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A behavioral approach to implementation of computer based management information systems.

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A BEHAVIORAL APPROACH TO IMPLEMENTATION OF COMPUTER BASED MANAGEMENT INFORMATION SYSTEMS

A Dissertation Presented

By

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To

Joy, Larry, Ali and Leigh

Thinking of them makes me smile

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When I reflect on the long chain of events that led to and through my dcctoral studies, numerous people come to mind. The seeds they planted, questions they posed and support they provided made this dissertation a reality.

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ABSTRACT

A Behavioral Approach to Implementation
of Computer Based Management Information Systems

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This is a research study of the factors affecting decision makers' behavior during the implementation of management information systems (MIS) to support decision making in organizations. To the decision maker the implementation is a trial period. The implementation or change process must produce adequate performance and behavioral effects which stimulate interest, early learning and acceptance. The effects must be such that the manager is motivated to make continued use of the MIS to assist him in his decision making.

These ideas are incorporated in the proposed model of factors affecting successful MIS implementation. From this model three variables in the implementation environment, type of facilitator, number of facilitators, and type of

terminal operation, were singled out for their importance. An experiment was established using a six group factorial design. Undergraduate students were randomly assigned to the six groups, and made production management decisions for 21 periods using a computer game.

Analysis of variance showed that during implementation decision effectiveness will be significantly better when:

1. a facilitating team is used rather than a single facilitator;
2. the facilitator is user oriented rather than systems oriented; and
3. the decision maker operates the terminal rather than uses a terminal operator.

The analysis also demonstrated that inclination to use the MIS in the future is significantly greater when:

4. a facilitating team is used; and
5. the decision maker operates the terminal.

These findings support the importance of team facilitation and direct terminal operation in changing decision makers' behavior. Implementation must promote decision maker involvement and the desired behavioral change to increase MIS use.

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INTRODUCTION

Our age is often characterized by an explosion of information and related technolcgical developments. Drucker (1969) has projected that "the impact of cheap, fast, and universally available informaticn will easily be as great as was the impact of electricity." Coping with these changes has become a continuing necessity today. To deal with these developments crganizaticns have spent vast sums of money and time on computers and information systems.

The computer came out of the laboratory and into organizational use in the 1950's. In 1970, the total annual value of sales and rental in the United States alone has passed five billion dollars. [11] During the 1970's, computer users' budgets in the United States have been growing at rates of 12% to 15% annually. By 1983, computer users in the United States will spend an estimated seventy-eight billion dollars directly cn computer equipment, services, supplies and personnel, up from forty-two billion today. [12] Many suggest that ccmputers have had a greater impact on modern organizational management than any other development.

1.1 Status of MIS

Organizations have devoted most of their funds and efforts in this area to transaction processing systems. However, in the past decade significant advances have taken place in the development of information systems to support managerial decision making. These management information systems (MIS) range from a relatively low to a high level of sophistication. They are likely to include one or more of the following capabilities: report generation, information retrieval from queries, arithmetic calculations, quantitative functions and modeling. While there may not be a concensus on what constitutes an MIS, they are generally computer based and function primarily to aid decision making. The computer can process and output enormous quantities of data in a myriad of forms at lightening speeds. How this data is perceived and used is the important question. The influence and effects the data have depends on the decision maker and environment as well as the information system. People are skilled at pattern recognition, exploring, problem finding, and handling unstructured decision prccesses. What is needed is an effective coupling of the decision maker with the computerized information system to enhance the decision making process.

But what has their impact been on managerial decision making? Have decision makers taken advantage of this explosicn? Is managerial perfcrmance being improved because of increased availability cf information and related technology?

The literature suggests that an effective coupling of the decision maker and the MIS has not taken place. "Some systems have been withdrawn because they have proved unworkable, and others continue to operate though no one uses their cutput." (Lucas 1975). Most management informaticn systems have not matched their expectations and some have been outright failures. This in turn, has led to the failure of many data processing managers to survive in their jcbs. (Nolan 1973 and 1976). While studying the management infcrmation system user, Schewe (1976) concluded from a number of these studies, "that current, or planned computer-based management infcrmation systems and other usage fell far short cf their theoretical capabilities." This failure of MIS to live up to their expectations is supported by the research cf Ackoff (1967), Couger (1968), Dickson and Powers (1973), Diebcld (1969), Lucas (1976), and Weinwurn (1970). Lucas (1976) relates one survey of the application series Management Science from January 1971 to June 1973 reported 150 articles on applications. Of the models in these articles, less than 3% had been implemented, that is, used more than cnce.

On the other hand, one of the generalizations drawn from a recent (January 1977) ccnference on Decision Support Systems (DDS) was that a number of DSS have been very successful. (Carlson 1977). In addition, Schewe (1974) cites a number of ccmpanies that have found very successful ways to use their computer systems, though he supports the general dissatisfaction noted above. In summary, there is little evidence in the literature supporting or even suggesting the success of the majority of MIS.

The questicn thus arises, why haven't these information systems been more successful? Or from a research viewpoint, what factcrs cr conditions will cause decisicn makers to make more effective use of MIS and be more willing to use them in the future?

1.2 Technological Environment

Sometimes a technolcgically oriented response has been given to the questicn cf why haven't these management information systems been more successful. These responses generally stated that the necessary advanced technology wasn't available, or wasn't sufficiently implemented in organizations. This argument went on that the lack of advanced technology caused designers to develop systems which didn't respond tc management's needs. The faults that have been mentioned with these systems include: inability to integrate data, slow response times, dedication of the computer to other tasks during large parts of the day, physical separation of machine access from decision makers, etc. These answers were primarily those given by the systems personnel, and were most prevalent in the 1960's. General managers usually lacked the knowledge to question these responses.

Even if these reasons contributed to the lack of success of MIS in the 1960's, they have largely been overcome in the 1970's. The advances in computer and computer related technology have been phenomenal in the past twenty-plus years. The increases in computing speed, memory capacity and speed, and reliability have been by orders of magnitude. During these years, software-based concepts, e.g. multiprogramming, time sharing, etc. have increased

the "throughput" of computer processing jobs. These trends can be expected to continue into the 1980's. (Turn 1974) These developments have led to an enormous increase in the number of computers in use. Most organizations of even moderate size make some use cf computers.

In the current decade these developments have reached the stage to support sophisticated management information systems with the characteristics needed for management control decision-making. The technology needed for these MIS include: low cost and easy to use terminals, large data bases, reliable communicaticns networks, multiprocessing of jobs and sophisticated software to support all of these.

Many of the terminals currently in use have video capability. They are impressive with their speed of response, silence, and ability to portray graphs and complex designs. Most of the past and current applications of computer video have either been very unsophisticated displays, e.g. the quantity on hand in response to an inquiry into the inventory status of an item; or quite sophisticated, e.g. the movements of an airfoil under stress as its design changes. The benefits of computer graphics use in engineering and design has been significant. Reductions in design time have ranged from 5.1 to 10.1. (Siders 1966) Studies have also shown that engineers have had no more difficulty in learning to use graphic terminals

than they did with more traditional computer systems. Because the benefits keep increasing, interactive graphics has entered a phase where it will be widely used. (Newman and Sproull 1973)

The number and value cf such terminals in use have become quite impressive. One study estimated 418,000 CRT terminals worth $1.45 billion installed at the beginning of 1975. The study projected that the annual rate of units shipped will double by 1980 to 221,000 per year. The study found that cnly 1.5% of the units currently installed had graphic capability. [13] Ancther study estimated that there will be 2.3 million application-oriented terminals installed by 1980, worth $10 billicn, although part of these may not have video capability. [14]

Another illustration of the breadth of computer video impact is taking place in England. Computer generated data are being shown by British televisicn in people's homes. By pressing buttons, the viewers can get up to 100 pages of alphanumeric and graphic displays cf information on news, weather, the stcck market, sports scores, etc. (Gilder 1976)

There has been significant development in the other technological elements needed for MIS. Improvements and acceptance of data base concepts and software are increasing. Many organizaticns have developed, or are

developing, data bases. Comparable developments are taking place with computer scftware for multiprocessing and communications. Some additional developments are still needed for interactive graphic command and cortrol software for video terminals supported by data bases; specifically, ones oriented to the manager-machine interface. (Martin 1973, Newman and Sproull 1973)

Another change began to take place in the past few years, the widespread use cf purchased application software. Because of the expense, time and lack of qualified perscnnel, organizations are turning to outside firms for many of their computer programs. The using firms are buying more of both standardized and custom designed software.

Thus the technological environment seems adequate fcr the development of sophisticated MIS. In addition, this advanced technology has been implemented in a multitude of organizations. Nc lcnger does it seem reasonable to cite technological limitations as a cause of the lack of success of MIS. Perhaps this is one of the reaons why current research into factors causing decision makers to be effective users cf MIS, has turned away from technological issues. One might add that concentration on technological concerns has nct prcduced the hoped for explanations.

1.3 Managerial Decision Making Environment

As the focus has shifted from just technological concerns, the behavioral issues have come to the fore. Specifically, is there something in the decision maker-MIS interface that is critical to effective use of MIS by decision makers? What is needed is research into the managerial decision making-MIS environment.

Before examining this question, let us look at the decision-making process.

One important consideration is that this process is not understood very well. No one is quite certain how managers go about making their decisions. We suspect that it is subjective and varies greatly from one person to another. We know that some managers make much better decisions than others; better in the sense that the decision has helped improve the performance of the organization. It is reasonable to assume that the process can be broken down into problem finding, i.e. determining when a decision should be made, and problem solving, i.e. selecting a course of action. The problem finding component can be expressed as the question of: when should a manager take action to control the use of a resource? The decision for action may stem from actual or potential out-of-control use; or it may stem from changing organizational environment. The changes could be in goals, plans, budgets, technology,

people, etc. The changes could be caused by factors external or internal to the organizational unit of concern. Often there is more than one manager's area of responsibility involved. Gocd solutions from these types of managerial interventions can have a high payoff.

In almost all of these situations a manager's experiences, behavioral style and role environment affect his decision process. He gces about searching the environment for conditions needing decisions, i.e. problem finding. In his search, he may not be consciously aware of what are the critical decisions and key variables. He may use fixed or variable control limits and time horizons when analyzing the data. The manager is also subject to the potential for a large and varying number of delays in receiving pertinent informatien. The delays can be caused by his problem finding approach, the number and pressure of demands on him, and perhaps, most importantly, the informatien system supporting his decision-making.

Today, managers get mcst of this information as data supplied by others. While scme of the data comes directly from others, much of it comes wholly cr partially on computer produced reports. With the increasing efforts being spent on MIS, the percentage of information coming through the computer should ccntinue to rise. One aspect of these computer reports is the very large amounts of data

that they furnish. Often managers feel inundated with the data and have difficulty coping with the volume. (Miller 1956) It is not unusual to enter a manager's office and find reams of computer reports stacked up and often unused. Perhaps managerial inability to deal with this information overload may be a major cause of the lack of use of MIS.

Many of these conditions and effects carry over to problem solving. In addition, the same information in the same situation can lead two managers to different solutions or even to different conclusions about whether any action should be taken. There is the further complexity that managerial activity operates in social systems, and in social systems no two situations are the same. It may also be that the same manager, seeing the same information, in relatively the same situation, may reach different conclusions at two separate times. We can add to these factors the decision constraints of time and expense. Managers are facing continually increasing demands on their time and they are becoming increasingly expensive resources for an organization.

How then can we design an efficient and effective information system to support a single manager when his goals, perceptions, and even decision processes may change, and change unpredictably? Yet these systems must support several managers to make the benefits worth the costs.

The aforementioned conditions could be used to describe today's environment for using information systems in managerial control decision-making. This environment can be characterized as follows:

1. Dynamic
2. Multidimensional
3. Partially structured with complex inter-relationships
4. Requiring managerial judgment
5. Affected by behavioral process
6. Involved with large amounts of data
7. Subject to information delays and missing or inaccurate data
8. Lacking in precision
9. Influenced by computer technology and MIS design
10. Dependent upon expectations and subjective probabilities
11. Having large monetary and human value effects
12. Built around the financial structure of the firm

Thus the design and implementation of the management information system must consider these characteristics. It is readily apparent that these characteristics produce a complex environment; an environment where both behavioral and technical issues have major impacts.

1.4 Focus of the Study

Let me summarize what has been stated. Our age has produced an explosion of information and technological developments. Organizations have spent and will continue to spend vast sums on computers and information systems. Despite this spending most MIS have failed to live up to their expectations. Sometimes the cause of this failure has been attributed to the lack of sophisticated technology in organizations. However, technological developments and implementations in the 1970's have lessened this as a major cause of the lack of MIS successes.

Despite the technological developments, research help for system designers and developers has been limited, though increasing. The factors causing acceptance, use and success of management information systems have not been established. Therefore it is not surprising that system designers and developers continue to spend much of their time concentrating on the technical capabilities of the information systems. This is their area of expertise. The developers devote their energy to what they know and where their results will make measurable improvements. This concentration may be improving transaction processing systems. With management information systems, a primary technological focus seems misdirected.

In searching beycnd the technolcgical factors, researchers have recently focused on behavioral concerns. They have begun locking at the managerial decision making - management information system interface and environment. This environment is complex, dynamic and not very well understood. But it is an environment in which both behavioral and technical issues have major impacts. In addition, the technical improvements are only beneficial if the informaticn systems are used. For managers to accept and use informaticn systems, they must feel that the system will result in imprcved performance in their managerial positions. Manacers will generally use supporting methods that they know, have used and have confidence in.

The growing use of purchased software lessens the impact that managers can have during systems development. The less the influence and ccmmunication that managers have during system develcpment, the more critical the implementation period is tc the systems acceptance and use.

For these reasons this study has focused on factors causing change in managerial attitude toward and confidence in information systems. As Schewe stated (1976), "For if the behavioral prcblems of infcrmation systems users are not reckoned with, no matter hcw technically competent an MIS is developed, its true potential will never be realized."

To investigate this change process, this research concentrated on the period when managers are first introduced to the MIS. This is a trial period when managers learn about and how to use the MIS, and the benefits of the system are touted. It should be the time when managers are most receptive to change. If during the trial managers can be shown that MIS can aid in improving job performance, then the managers should be willing to try and use the MIS with their ongoing managerial activities.

Specifically, this study investigated the impact of certain key variables during this trial period on managerial job performance and attitude.

1.5 Overview of the Study

Chapter One introduced the subject. It broadly stated the issues of concern and why they are important. The general lack of established knowledge in the subject was noted. The chapter concluded with the focus of the research: tc investigate the impact of certain key variables on managerial jcb performance and attitude during the period when managers are introduced to new information systems.

Chapter Two reviews the literature and discusses the State of the Art. The chapter begins by proposing a simplified model of the successful implementation of MIS. A number of research framewcrks are presented which conceptualize the behavicral as well as the technolocical issues. These frameworks are used to expand the simple model into a more ccmprehensive model. Then the theories, methods and findings of cthers are analyzed. Chapter Two moves toward a focus on certain environmental conditions that may be of key importance during learning and implementation of MIS. The chapter concludes with a summary.

Chapter Three presents the Research Model. It relates the general issues, theories and research in the first two chapters to the specific intent and design of the research. The intent and design includes:

1. Developing a research model.

2. Designing a methcdology based upon the research model to collect and analyze the data.

3. Drawing inferences that the key variables can be used to predict the effectiveness of management information systems and the inclination of decision makers to use them.

4. Generalizing from this knowledge so strategies could be determined which increase the chance of developing successful management information systems.

A complete research model is proposed. Then Chapter Three discusses the independent variables that were chosen for examination and presents the hypotheses related to the variables that were tested. Chapter Three concludes with a descriptive research model.

Chapter Four covers the methodology that was used for the research. It describes the management game that was used as the experimental vehicle. It discusses the subjects, who were students, and the method of assigning them to the experimental groups. The chapter explains the selection, training and characterization of the facilitators, one of two independent variables. It explicates how the experiment was conducted. Finally Chapter Four elucidates the methods of gathering the data.

Chapter Five reviews the data analyses and presents the results. Since a multivariate analysis of variance was used the dependent variables are analyzed jointly and separately. The results of all the analyses are given. Each place is

noted where the variables displayed significant variance.

Chapter Six discusses the independent factors in light of the results that were found. It interprets the results and draws inferences about the importance of the orientation and number of facilitators, and direct versus indirect computer terminal operation. The confirmed hypotheses are related to the research model that was proposed. Chapter Six concludes by emphasizing the importance of these independent factors in the learning and implementation period on managerial acceptance and use of MIS.

Chapter Seven mentions some of the limitations of the study and proposes directions for additional research. It includes the weaknesses in the performance and behavioral measures that were used, the experimental environment chosen, the use of students as subjects, limitations presented by the sample size, and possible other factors confounding the results. The chapter covers the desirability of replicating the research with real organizations, actual managers and other facilitators. It relates the variables that were studied with other possible independent factors.

The study concludes by discussing prospects for the future.

C H A P T E R I I

THE STATE CF THE ART

Chapter One introduced the subject of the study. It covered the failure of most MIS to live up to their expectations. It noted the lack cf established knowledge of why MIS are not more widely accepted and used.

This report has suggested a variety of areas for research into the factors, conditicns and relationships that will lead decision makers tc more effective use of management information systems, and greater inclination to use them in the future. One could look at the MIS, the decision maker, the information available, the decisions to be made, the tools, methcdology and models, and certainly the environmental factcrs. Research could be done on the interface or integration cf more than one of these factors.

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To expand the frcntiers of knowledge and gain acceptance of the hcped for findings, this research must be related to the theories and research that have preceeded it. For this reascn, Chapter Twc discusses the State of the Art.

This chapter proposes a simplified model of the successful implementaticn of MIS. A few of the more significant frameworks that have been proposed for conceptualizing ccmputer based management information systems are discussed. These frameworks have been the basis for a great deal of MIS research effort. This effort in turn has produced a growing bcdy cf theory and empirical evidence. These framewcrks are used to expand the simplified model. The theories, methods and findings of others are analyzed and related to the model.

Chapter Three follows with the specific research model used for this study. The balance of the chapters present the research methcdology, data collection, findings, analyses, conclusicns and directicns for additional research.

2.1 Research Framework for MIS

One way to develop a framework for conducting research is to start with a simplified model. The model should contain the key classes of variables of concern. These classes of variables can then be expanded and explored by relating them to the theory and findings of others. This was the method chosen to define the research model used for this study, and give assurance that the research is at the state of the art.

2.11 Simplified research model. Management information systems are developed so that they will be used by decision makers. Chapter One noted the failure of most MIS to live up to their expectations. Therefore, one major variable in the research framework for MIS was a measure of the success of MIS implementation.

Since the subject of concern is successful implementation of MIS, some characteristics or qualities of the information systems must affect their success. Thus MIS characteristics became the second major variable in the simplified model.

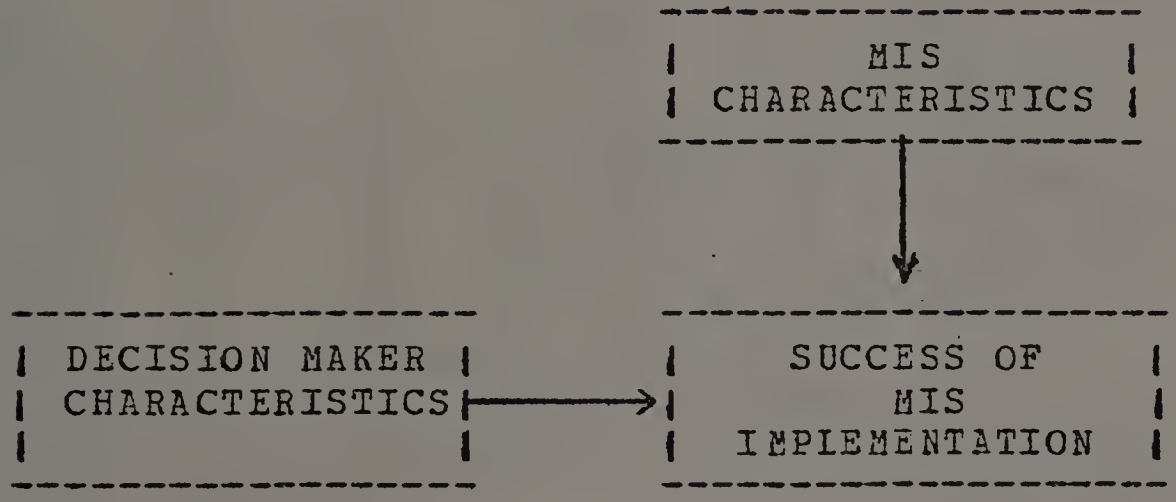
Thirdly the decision maker chooses to use or not use the MIS. Therefore it seems reasonable to assume that some characteristics or qualities of the decision maker will affect his use and thus the success of the MIS. The

characteristics of the decision maker became the third variable in the research framework for MIS.

These three variables form the simplest of models. Their relationship is shown in Figure 2.1.

FIGURE 2.1

A SIMPLIFIED MODEL FOR MIS RESEARCH



2.12 Expansion of the research model. In a working paper, Chervany, Dickson and Kozar (1972) proposed a framework for research in MIS which had three significant features to warrant its inclusion here. First, their framework contained measurable dependent and independent variables. Second, it contained the three variables in the Simplified Model, plus an additional variable, the decision environment. Third, it served as the direct foundation for a number of empirical studies known as "The Minnesota Experiments". Their model suggests variables that should be examined for their impact on decision effectiveness. The model is shown in Figure 2.2.

FIGURE 2.2

CHERVANY, DICKSCN AND KOZAR'S MODEL

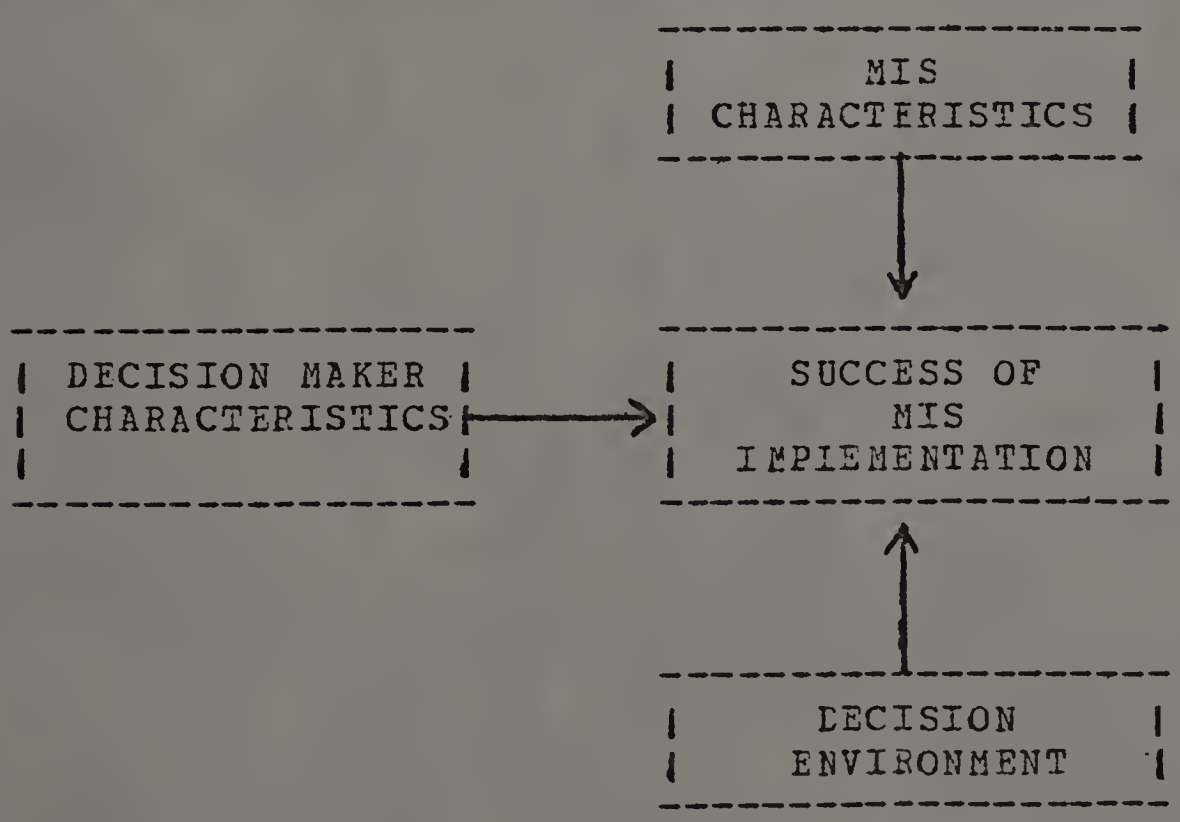
INDEPENDENT VARIABLES			DEPENDENT VARIABLES
The Decision Maker	The Decision Environment	The Characteristics of The Information System	Decision Effectiveness
1. Indirectly Acquired Attributes -Aptitudes -Attitudes	1. Function -Finance -Production -Marketing -Personnel -R & D etc.	1. Format -Content -Form -Presentation Media	1. Quality of MIS -Cost -Profit -Time etc.
2. Directly Acquired Attributes -Training -Experience	2. Level -Strategic -Tactical -Operational	2. Time Availability	
	3. Environmental -Stability -Competitiveness -Time Pressure	3. Decision Aids	

Chervany and Dickson joined with Senn in discussing these variables and the results of "The Minnesota Experiments". (Dickson, Senn and Chervany, May 1977). Decision effectiveness, their dependent variable, and "The Minnesota Experiments" are dicussed in the next section 2.2.

The three independent variables provide the basis for expansion of the Simplified Model presented in Section 2.11. These independent variables are discussed in Sections 2.3, 2.4 and 2.5. This Expanded Model is shown in Figure 2.3.

FIGURE 2.3

AN EXPANDED MODEL FOR MIS RESEARCH



Support for this Expanded Model also comes from the conceptualization of Mason and Mitroff (1973). In a proposal for research in information systems they state: "that an information system consists of at least one PERSON of a certain PSYCHOLOGICAL TYPE who faces a PROBLEM within some ORGANIZATIONAL CONTEXT for which he needs EVIDENCE to arrive at a solution (i.e. to select some course of action) and that the evidence is made available to him through some MODE OF PRESENTATION." Their model consists of the variables emphasized in their quote. Their conceptual basis for research is on the process of using information systems to support decision making. Their focus is to give each type of decision maker the kind of information he is psychologically attuned to and will use most effectively.

2.2 Success of MIS Implementation

A theme that has run through this paper is the importance of MIS success. It was suggested in Chapter One that managers must accept and use MIS for them to succeed. It also seems reasonable that for managers to continue their acceptance and use of MIS, their usage of the MIS should have positive effects on the managers' decision performance.

The goal of any aid for decision making is to improve the effectivess of the decision. Yet in the field it is quite difficult to identify the independent variables causing improved effectiveness. Dickson, Senn and Chervany (1977) state that "Laboratory studies appear to offer the most immediate promise for improvements in the current state-of-the-art on information systems analysis and design."

2.21 The Minnesota Experiments. These authors report on a group of nine such studies known as the "Minnesota Experiments". Each experiment was a computer-base simulation or experimental game. Each experiment used a simulated environment emphasizing decisions in either production, procurement, inventory control, commodity management or risk analysis. Three experiments used undergraduates, three used graduate students and three used managers or specialists.

The dependent measures used in these experiments to evaluate decision effectiveness were primarily: decision quality, a cost or score in the experimental game, decision making time and confidence in the decision. In some of the experiments users were asked tc evaluate the information system. In other experiments the relative frequency of use of the information system was measured. In a few of the experiments the type of data selected was the dependent measure that was used.

The independent variables tested fell into two categories: system characteristics (e.g. form or media of output or use of decision aids) and individual attributes (e.g. quantitative aptitude, ccgnitive style, and risk taking propensity).

The experiments yielded mixed results and were not conclusive. The authors drew a number of implications from their research. Amcng the implications were:

1. The experimental gaming methodology has proved to be very useful in investigating cause-and-effect relationships in this area.

2. The existing research has clearly demonstrated that there is an important system/user/decision interaction operating which affects the performance results and user evaluation of an information system.

3. Systems with complex or unfamiliar attributes may produce low user ccnfidence and satisfaction with the systems even if cperating results are better. These attitudes represent a pctential barrier to successful implementation that training may not be able to overcome.

In two of the experiments (Chervany and Dickson, 1974, and Benbasat and Schroeder, 1977), the results revealed that subjects who made better decisions also took longer to make their decisions. None of the other experiments demonstrated statistically significant results at variance with this finding.

2.22 Other research. Carlson and Sutton (1974) reported a similar interesting observation from their case study of the training of police officers to use an interactive information system. They noted that their subjects took more time during interactive problem solving than when they had used traditional methods. However, this greater time did not inhibit or diminish system use.

Morton's small group research (1971) reported somewhat different findings. He found that learning to use an interactive data based MIS with video screens and graphing capability increased problem finding for managerial decision making. It worked well for recognizing patterns, detecting trends, seeing relationships, portraying the state of critical variables and permitting future projections. His system had a favorable effect on managers' response times and changed their decision making processes. It increased the managers' use of the information system and their satisfaction with it. However, his data was gathered after an extensive trial and implementation period. Morton used a

very small sample, one group of three managers. He had no control group. This raises the question of the validity of his findings. It nonetheless is quite valuable as exploratory research.

2.23 Implications for MIS success. These limited findings suggest what may be a counter intuitive idea. It is often said that time is one of a manager's scarcest resources. Jones (1968) emphasizes the value of saving a decision maker's time. Grayson (1973) states, "Management scientists simply do not sufficiently understand the constraint of time on decision making and particularly on decisions that count; and the techniques they develop reflect that fact." He specifies the "need to build the time factor into models instead of leaving it as an exogenous variable." We normally feel that for an MIS to be used it should save time for a decision maker. While this is probably true over a lengthy period, the opposite may be true during learning and implementation. Recall the results from the "Minnesota Experiments" above. Perhaps those decision makers who commit themselves to learn and use an MIS are those who take more time during the initial stages of use.

The studies reviewed in this section examined MIS success during the implementation period. These authors and many others view the period of decision maker learning and change as critical to later acceptance and use of MIS. It

seems necessary tc make these decision makers sufficiently receptive during their irtrcductiocn to the MIS. They must feel that their job perfcrmance will probably improve if they use the MIS in the future. Decision makers will generally learn and use new supporting methods if they see improvements in the effectivess cf their performance during their learning pericd.

2.3 Decision Environment

Managerial decisions are always made in some organizational environment. Therefore the type of environment should have some effect on whether a manager uses an MIS to assist him in the decision making. This decision environment can be characterized along several dimensions. The importance of any dimension on MIS use will probably vary with each decision, organization and other factors.

Chervany, Dickson and Kozar (1972) presented three dimensions of the decision environment: decision level, organizational function, and organizational environmental pressures (see Figure 2.2). Another environmental factor to be considered is the importance of the decision. This might be expressed as the cost/benefit trade-off among decision alternatives. One could continue to enumerate organizational characteristics which might influence a decision maker's use of an MIS. However it is more pertinent to this study to discuss a few of the prominent environmental dimensions which characterize the decision itself.

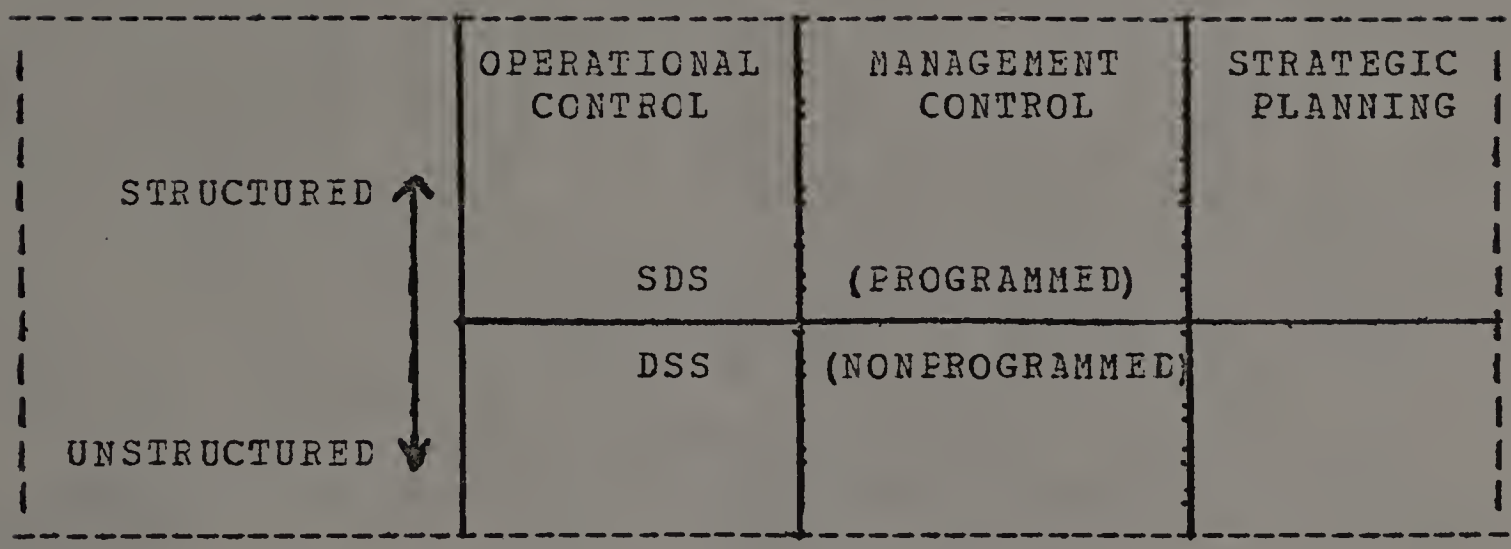
2.31 Level of decision making. Much of the literature categorizing information systems and relating them to managerial decision making are based on Anthony's framework

for planning and control (Anthony, 1965). This framework classifies decisions for operational control, managerial control and strategic planning. Operational control deals with day-to-day issues and the completion of specific tasks. Strategic planning is at the other end of a continuum dealing with long range infrequent decisions. "Management control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives." (Anthony, et.al., 1972)

2.32 Decision structure. Gorry and Morton (1971) added a second dimension of decision structure to Anthony's framework. They base this dimension on Simon's (1966) differentiation between "programmed" and "non-programmed" decisions. Gorry and Morton classify MIS into "Structured Decision Systems" (SDS), those which support structured or programmed decision making, and "Decision Support Systems" (DSS), those which support partially or wholly unstructured decision making. The essence of Gorry and Morton's framework for management information systems is shown in Figure 2.4.

FIGURE 2.4

GORRY AND MORTON'S FRAMEWORK



After presenting this mcdel they emphasize the differing nature of the decision prccess for different types of decisions. This is true as you move from structured to unstructured decisions, as well as for changes from problems in operational contrcl tc management ccntrol and strategic planning. Because cf the highly dynamic nature of the decision process, Gorry and Morton state "there is much more to be gained by imprcving the information processing ability of managers in order that they may deal effectively with the information that they already have, than by adding to the reams of data confronting them, or by improving the quality of those data." They conclude that the requisite skills of the decision support system builder be different from those typically possessed by the builers of operational control systems. What is needed is close interaction with management during development. They add "systems in this area must be able tc assist the evolution of the manager's decision making ability through increasing his understanding of the environment."

2.33 Decision level and structure and MIS use. Gorry and Morton presented a framewcrk of information systems dealing with the level and structure of decisions. Since the primary concern of MIS is application and use in organizations, it seems appropriate to look at the level and structure at which they are aimed. A number of surveys have

shown that most information systems were developed for operational control. (Brady, 1967, Churchill, et. al., 1969, Lucas, 1974) It is not hard to understand the reason for this focus. Computer systems dealing with operational control situations where decision making follows well structured guidelines are the easiest to define, develop and get accepted. They generally have the most immediate and tangible impact. For these and/or other reasons their usefulness have generally been accepted.

More recently MIS have begun to be used as aids to managerial control decision making, (Dickson and Powers, 1973, and Gibson and Nolan, 1974) and decision support systems (Carlson 1977). The impact of these systems are much harder to assess. Not only is it difficult because of their newness, but because of the lack of explicit agreed upon criteria by which they should be evaluated, and their success or failure judged. Yet research into these systems cannot be ignored despite their complexity and the difficulty in evaluation. Managerial control and DSS systems present opportunitites for significant positive impacts on organizations.

At the highest level of decision making we find strategic planning. A 1972 survey of corporation presidents indicated that "the utilization of computers in unprogrammed decision-making, however, is limited and the involvement of

top management with computer systems is similarly limited." (Ference and Uretsky, 1976)

While there may not be a consensus on what constitutes an MIS, Ives, Hamilton and Davis (1977) point out that "MIS researchers have focused not only on the management-oriented information system but also on transaction processing systems in organizations." They base this on a literature search which included a review of 180 doctoral dissertations related to MIS research written between 1972 and 1975. In addition, Lucas (1975) and Kramer (1969) conclude that investigation into the success of MIS should be concerned with the operational and managerial control levels.

2.4 Decision Maker

Chervany, Dickscn and Kozar (1972) proposed looking at decision makers alcng twc dimensicns in their framework for research in MIS (see Figure 2.2). These two dimensions separate the decision makers' attributes into those indirectly acquired and those directly acquired. The former are attributes that the decision makers were born with or developed over a lcng pericd of time. The latter are ones that have a much more recent origin. Mcre importantly, those directly acquired attributes are ones organizations can affect. If those directly acquired attributes are significant in causing decision makers to use MIS, then it would be quite beneficial for organizations to understand the relationships involved.

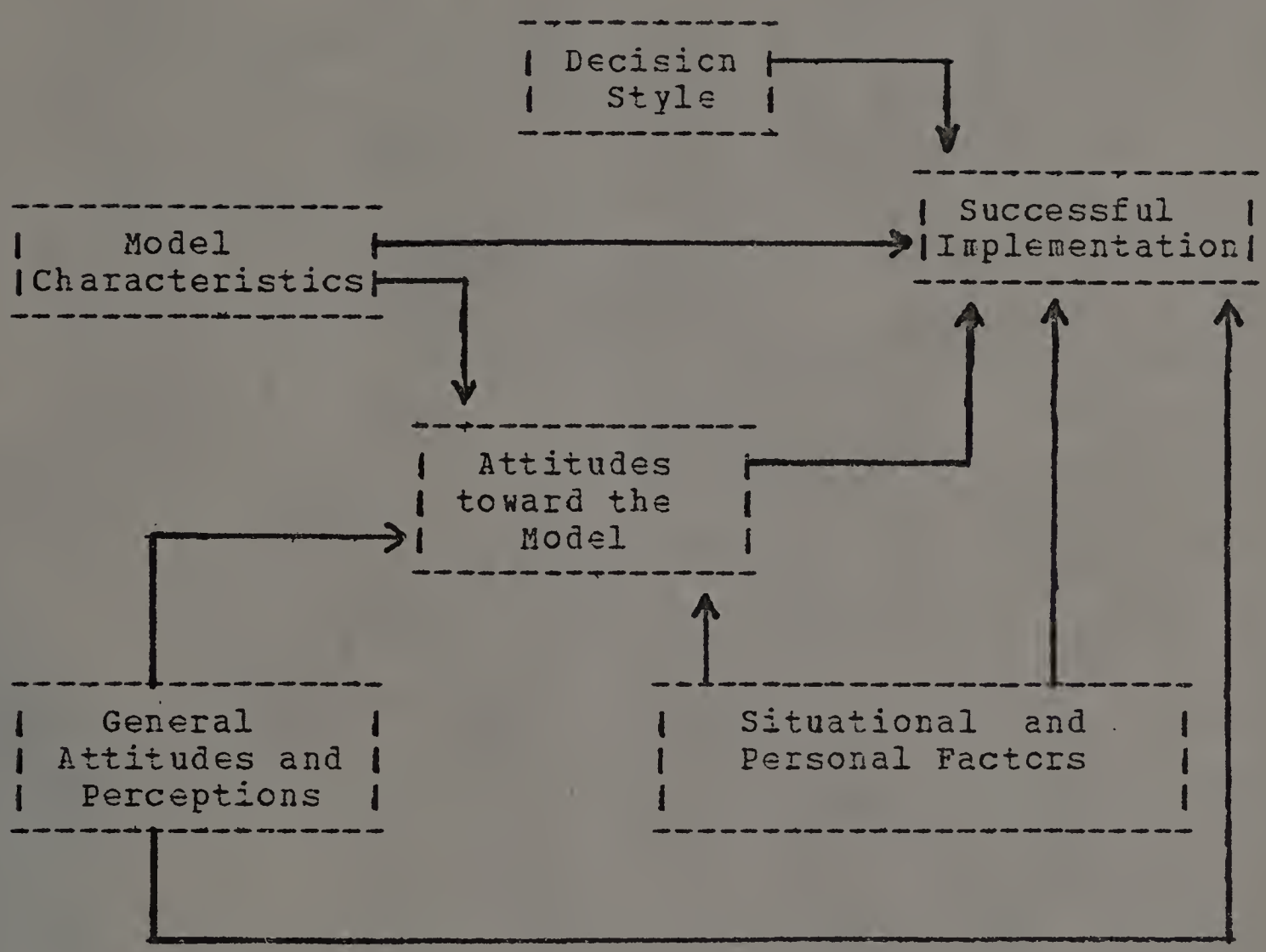
2.41 Directly acquired attributes (attitudes and experience). Lucas (1975) developed a descriptive model of information systems in the context cf the organizatien from organizational behavior and information systems literature, as well as from studies he conducted. The model focuses on three crucial variables: user attitudes and perceptions, the use of systems, and user performance. He proposed and tested 16 propositions among 10 classes of variables which included the crucial three.

Based upon the results cf this research, Lucas (1976) presented an updated research mcdel. He adopted high levels of use as an indicatcr cf successful implementation. He stated, "Use is probably the most frequent dependent variable for measuring successful implementation in studies described in Chapter 1, for implementing bcth operations research models and computer- based information systems." He continued, "Attitudes are a gocd predictor of behavior; knowing scmething about an individual's attitudes provides the basis fcr making predictions on how he will act. We expect favorable attitudes to be associated with high levels of use of a computer-based model ----."

This updated model consists of six classes of variables and is shown in Figure 2.5.

FIGURE 2.5

LUCAS' RESEARCH MODEL



Lucas presented eight propcsitions involving the six classes of variables. He fccused on attitudes toward interactive computer based models and successful implementation of the models. These propcsitions can be summarized as:

1. Successful implementation, or high levels of use, of information systems are the result of certain ccmbinaticns of: the user's decision styles, the information system model characteristics, the user's general attitudes and percepticns, the user's situaticnal and perscnal factcrs, and the user's attitude toward the model.

2. The user's attitude toward the model is in turn a result of: the model's characteristics, the user's general attitudes and perceptions, and the user's situational and personal factors.

A number of other studies have been conducted, (Adams, 1975, Dickson and Powers, 1973, Diebold, 1969, Lucas, 1975 and 1976, and McFarlan, 1971), which ccnclude that user satisfaction is one of the key criteria for a successful MIS. However, these studies lack experimental support for their findings. In contrast, Schewe (1976) found no relation between users' attitudes and their use of MIS.

Lucas' and Dicksen and Powers' studies both develop significant positive correlaticns between user satisfaction and the use of MIS. Both of their user satisfaction factors are composite factors frcm:

1. User percepticns cf their cwn involvement and control of the systems development projects and of the cperation of the MIS.

2. Upper management's support for the project.

3. The quality of the system.

Lucas' recent results show that a manager's use of the outputs of an MIS has a positive relationship with both the manager's perception of his involvement in settings goals for the MIS and his compensation. (Lucas, 1975 and 1976) He finds most managers not using the information systems to examine existing data. He proposes that the MIS should move to support the asking of "what if" questions.

Dickson and Powers' research (1973) support the positive relationship between MIS success and participation by operating management in determining system design specifications. Diebold's (1969) survey indicates managers are not setting systems specifications and goals.

While most of the research reported is exploratory in nature, it provides evidence for the importance of the behavioral component in MIS use.

Those directly acquired attributes can probably be operationalized best through examination of a decision maker's attitudes and experience.

2.42 Indirectly acquired attributes (aptitude and style). One reason why decision makers may not use their MIS may stem from Simon's (1961) argument, that man's behavior is more directed toward satisficing rather than toward optimizing. Man does not continue to search until he has

considered all alternatives. "Administrative Man" makes choices taking into account just a few of the factors he regards as most relevant and crucial. The managers who do this limit their capbilities and diminish their firm's ability to compete in today's world. For as Toffler (1970) says, the acceleration of change has radically altered the balance between the novel and the familiar situations. It causes individuals to process far more information at extremely high rates of speed to maintain rational behavior and predict with fair success the outcome of their actions.

For a manager to make more and better use of an information system, it has to directly affect the basic components of his planning and control processes. Most managers cannot explicitly describe their decision making process. Often they are unable to state specific objectives for an information system to assist them in their decision making. We can follow Ware's (1975) description of management as a creative process of choosing objectives, knowing opportunities and risks, assessing progress and then devising continual adjustments to realize objectives most effectively. With rising risk levels and growing demands, progress turns on how well the information system performs in interfacing with management.

Within this decision making context, many authors have suggested reasons why managers have not used MIS in their decision making. Or ccnversely, how MIS must be developed to be useful. (Ackcff, 1967, Boulden and Buffa, 1970, Davis, 1975, Grayson, 1973, McFarlan, 1971, Nolan, 1973, Schewe, 1976, and Zani, 1970)

Ackoff's arguments are widely cited. He states five assumptions commonly made by designers cf management information systems which he feels lead to major deficiencies in the resulting systems. "These assumptions are: (1) the critical deficiency under which most managers operate is the lack of relevant infcrmation, (2) the manager needs the infcrmation he wants, (3) if a manager has the information he needs, his decision making will improve, (4) better ccmmunicatien between managers improves organizational perfcrmance, and (5) a manager does not have to understand how his infcrmatien system works, only how to use it." These assumptions are a logical and analytical response to pecple and situatiens which are not necessarily logically oriented cr arranged.

Doktor (1976) discusses two distinctive ccgnitive styles that managers pcssess. One is analytical, logical and sequential. The other is intuitive, heuristic and global. He suggests everyone has bcth styles, but one style is dcminant in each person.

In a similar vein, McKinney and Keen (1974) develop a model of a manager's cognitive style along two dimensions: problem finding and problem solving. In problem finding, managers vary from preceptors - looking for cues, relationships and deviations; to receptors - focusing on detail and trying to derive relationships. Their problem solving scale is similar to Doktor's cognitive style distinction.

Doktor proposes that a key difficulty in implementing MIS is a consequence of cognitive style mismatches between the system designer and the user. These mismatches will often lead to resistance by the user.

Leavitt (1975) reaches a similar conclusion. He says that analysts believe that when managers are given a set of options they will analyze them logically and choose the best one. He adds "But of course the world doesn't behave that way. Even rational analysts know that the world out there, where implementation must take place, is largely peopled by nonanalysts." Leavitt goes on to say that when analysts encounter implementation problems, they fall back on their best skills, the analytical ones, and fail. "And then they will try either to be more rationally persuasive or to fall back to a more primitive alternative-power."

Leavitt proposes a "fertilizer approach" to implement and support management decision making aids, particularly for problem finding. He adds, "The fertilizer approaches do not try to analyze the insides of the problem so much as they try to manage the conditions under which man thinks about the problem."

What this suggests is a need to look at the conditions and environment under which managers are introduced to and learn about MIS.

2.5 MIS Characteristics

MIS characteristics are probably the most frequently theorized and tested type of variables in searching for factors affecting MIS success. Chervany, Dickson and Kozar (1972), Mason and Mitroff (1973), Lucas (1976), and others all included MIS characteristics in their proposed models for research in MIS. "The Minnesota Experiments" among others were not able to establish significant relationships based just upon MIS characteristics.

We might conclude that although many authors have presented strong arguments for supporting their contentions, their reasons have seldom been supported by convincing evidence. Dickson and Powers (1973) said, "although a good deal has been published in recent years concerning the management of information systems, most of what has been published has not resulted from well conceived studies; the data to support the prescriptions just aren't available." Dickson, Senn and Chervany (1977) add, "Very few researchers have focused directly on the relationships betwen decision activities and information system structure. Among those studies that have been performed in this area, many have shortcomings which limit their usefulness."

2.51 Man-machine interaction. Martin (1973) states that "During its first two decades the data processing industry

paid little attentiон to effective man-machine dialogues." He adds, "The future growth of the computer industry and the acceptance of ccmputer methods will depend largely on the successful establishment of effective man-machine communications." The MIS must nct only provide information when and in the fcrm the manager desires, but make it easy for him to communicate with the system. Effective MIS will couple man and the computer utilizing the unique capabilities of each. Man is skilled at pattern recognition, handling unstructured decisicn processes, setting gcals, explcring, and problem finding. The computer is accurate, fast, has a vast memory and tremendous capability to manipulate and display information. Martin concludes that interactive graphic MIS with data-bases and cathode ray tubes (CRTs) are the direction tc go for dialogues between managers and the MIS for decision support. He further states that this type of system with charting capability wculd be most effective for communication with a manager in summarizing and manipulating data and using models.

Boehm and Watscn's research (1971) showed a tremendous variability in prcblem solving approaches among decision makers. They found that users tend to become dissatisfied if restraint is placed upon their free interaction with the computer. However, their results indicated that users tend to problem solve more effectively, use less computer time

and less of their own time in the process, when under mild restraint than when given freedom to access the computer, or when their access is severely restricted. This may be related to the users' expectancy of response time and how they organize their problem solving activity. One author (R. Miller, 1968) found that two seconds constituted an important boundary in the effectiveness of feedback through an interactive computer terminal. He continued that there was a sudden drop in mental efficiency when delays went beyond two seconds. Miller related this to the theory that people organize their decision making into clumps that can be easily completed, and to the limitations on the short-term memory. He concluded that terminal conversations must have a closure or response before the user will proceed to a new thought and that this response must be within the user's time expectation.

Booher experimented on human comprehension of pictorial versus printed information (1975). He found that speed of comprehension is greater with pictorial representation, but printed information is necessary for accurate comprehension. His results showed the highest comprehension with a combination of both pictorial and printed information.

Ijire, Jaedicke and Knight (1966) stress the importance of timing, reliability, and methods of presentation. Morton (1971), Rowe (1968), Schwartz (1971) and Boer and Everett

(1976) support this. Therefore the MIS must be effective in selecting, filtering and displaying key information in readily comprehensible fcrm without undo delays.

Emery (1971) describes the interface between the system and the user as one of the more critical design factors. He states, "Information must be perceived before it can have value for human decision making. The effectiveness with which a user perceives infcrmation is largely governed by the way which it is displayed." Among the general principles of good display Emery advocates are:

- Use graphical display when feasible.
- Avoid unnecessary precision.
- Use aggregation tc wash out irrelevant dimensions.
- Provide basis for ccmparison of information displayed.
- Provide links among displays, especially with hierarchial reports.
- Use exception principles with threshold values.
- Control limits for displays should be changeable as users see fit.
- Use ad hoc inquiries.

Most information systems in use err cn the side of providing far too much information. This, in turn, often results in overlooking significant facts, or worse, nonuse of the reports.

2.52 Characteristics of MIS in current use. A number of decision support systems (DSS) currently in use were presented and discussed at a recent conference on DSS. 21 Carlson (1977) drew the following generalizations about these DSS:

"First, DSS functions are likely to include a combination of information retrieval (query), computer-based models (simulation, optimization, decision analysis), data manipulation (arithmetic calculations) and report generation (tabular and graphical). Data entry and knowledge representation (artifical intelligence) also are important in some DSS.

Second, DSS tend to be operated by staff or low-level management, the end-users of the information are low-level to top-level managers.

Third, most DSS are interactive and receive regular use (often daily).

Fourth, flexibility and ease of use are the primary design and implementation goals for most DSS.

Finally, a number of DSS have been very successful, yielding net payoffs of millions of dollars."

2.6 MIS Implementation Environment

The preceding sections have indicated the issues and concerns with the research framework proposed in Section 2.1. These sections discussed the state of the art in research and theory on the variables in that framework. That research and theory presented a common focus on the decision maker and his use of the information system. It emphasized the importance of the behavioral considerations in the implementation and use of MIS. However that research has not presented convincing evidence on the factors causing managers to use management information systems.

This section delves more deeply into the research and theory bearing on the subject, it helps to refine the research issues, narrow the focus of inquiry, and lay the groundwork for the specific research model which was proposed and tested.

As was noted in Section 2.2, many of the studies examined MIS success during the implementation period. During implementation the decision maker's attitude and experience are shaped. These initial periods of decision maker learning, participation, and change seem vital to later acceptance and use of MIS. For this reason, the research on certain variables in the MIS implementation environment are reviewed in this section.

2.61 Facilitation and change to an MIS. Users of transaction processing information systems usually must use those systems. This is not the case with management information systems. Decision making is by and large a subjective and individual process. The decision makers are usually free to choose what supports they want to use for assistance. If this is so, then their learning, adaptation, and finally acceptance of the MIS are of critical importance to the use and effectiveness of the MIS. This learning/change/acceptance phenomenon is difficult to characterize and manage. It is even harder to determine the most important variables affecting the process and describing their relationship. Many authors have described the resistance to change in individuals from their familiar and traditional methods of operation. However, there is little research on how to overcome this resistance and gain acceptance and use of MIS for decision support.

In one field study, Schewe, Wiek and Dann (1974) found that user's familiarity with the systems to be the most important variable in explaining system usage. User familiarity with the system explained 35% of the variance of system usage. The next most significant variable explained only another 7%. The study was conducted with 30 representatives of 16 pharmaceutical firms using an on-line MIS to a marketing data base via CRT terminals.

In an experimental field study of ten food processing firms, Schewe (1976) found that "interactive system users emphasizing the need for a good working relationship with the people who operate and maintain the computer system." He also found the need for concentration on the basics of system improvements and better user training to improve user attitudes. Schewe developed an attitudinal model to explore the relationships between MIS users perception of their computer system, perceived variables exogenous to the system, attitudes and system usage. He found no significant relationship between attitudes and system usage behavior. He suggested that other variables may have overridden the influence of attitudes on behavior.

Bean (1972) conducted a related behavioral field study of interface structures during the implementation of management science (MS) projects. He found that "MS units who were linked to their clients through intermediaries had a higher proportion of favorable client relations and a lower proportion of unfavorable client relations than MS units which were coupled through direct contact." He also showed that "intermediaries whose functional orientation were similar to those of the client were involved in a higher proportion of effective MS/client working relationships than were intermediaries with audit and control responsibilities." The study data were obtained through interviews in two organizations that had adopted

dissimilar designs for coupling MS and clients.

Perhaps this facilitator is cne of the keys to gaining acceptance and use of the MIS. Bostrom and Heinen (1976) view MIS as an intervention strategy or planned change effort and describe the MIS designer as the interventionist. They specify seven conditicns which they claim "are the major causes of presert inadequate designs and unsuccessful change strategies." These conditions are all limitations in the views, concepts, theories and approaches held and used by typical MIS designers. Amcng cther recommendations they stress the need for users and designers to develop meaningful collaboration.

Keen (1975) states that it is of central importance to redefine the role cf implementing MIS in terms of organizational change. He argues that the systems implementor must be a change agent if systems are to be successfully implemented. Keen bases his thesis on the Lewin-Schein model of any change process (Schein 1961). This process has three key stages of behavioral change: unfreezing, change, and refreezing.

Bennett (1974) stresses the importance of an integrating agent in helping new users assimilate DSS concepts and develop required operating skills. He takes his view of the integrating agent from Lawrence and Lorsch (1969). That is, cne whc helps bridge the differences

between people, seeks resclution of conflict, and finds ways for differing functicns tc work together.

Galbraith (1973) also takes the integrating agent approach as part of his framewcrk toward new designs for complex organizaticns. He stresses liaison roles, task forces, teams and managerial linking roles as ways to create "lateral relations" between different functional groups to improve communications channels and increase information handling.

Narasimhan and Schroeder (1976) conducted an explcratory field study in eight crganizations implementing an OR/MS model. In each organization a single decision situation was selected and relevant data were gathered through questionnaires. Analysis showed that working relationships and technical validity (appropriateness of model/analysis) are the most important factors tested affecting the perspectives of the decision maker and change in the decisicn prccess. They describe working relationships as the level of interaction, presence/absence of mutual understanding, effectiveness of ccmmunication between scientists and managers. Their results also showed that simple models are inadequate tc explore the process of change. They recommend a staged approach to affecting change.

Ein-Dor and Segev (1976) postulate a model of the implementation of MIS. They develop a series of propositions describing the variables relating to the implementors which impact on the success or failure of the MIS. They reach four conclusions:

1. The composition and personality of implementation teams and the quality of project leadership have major impact on the success and failure of MIS.

2. There is a major problem in achieving a correct mix of people with technical and organizational knowledge on the implementation teams.

3. The personality traits best suited to system implementation have not yet been identified. It is clear however, that a high level of interpersonal skills is desirable for all levels of implementors.

4. The selection of appropriate project leadership causes considerable difficulty because of a lack of evaluation criteria for personnel of this type.

The aforementioned research suggests that attention be directed toward the facilitator(s) of MIS during systems learning and implementation. Particular concern should be given to the effect of functional orientation, number and role of facilitators on the decision makers effectiveness and willingness to use the information system.

2.62 Direct vs. indirect system operation. The concern throughout this chapter has been the decision maker and his use of the information system. With many information systems the decision maker only interfaces indirectly. That

is, his contact is the receipt of a report either routinely or in response tc a request made sometime previously. However, cne of the more recent developments has been direct terminal access to the MIS. With these, the decision maker can exercise more direct ccntrol cver the timing, content, detail and form of the MIS output. In addition, he can direct this contrcl frcm relatively convenient and familiar locations. Most cf these terminal oriented information systems expect the decision maker to directly operate the terminal. This expectaticn requires that the decision maker know and have recall of: the MIS, its data base, the command instructions tc call for the data, hcw to manipulate and format it, and the operation of the terminal keyboard. He must do that while carrying out his important functions of problem finding and solving. While this may not present a problem after he has gained system knowledge and operational skill, it may well be a barrier to effective use during implementation. If these barriers to learning and expertise take tcc long to master, are difficult to overcome, or call fcr behavior that is inconsistent with a manager's percepticns of where his effort should be put, then they may never be overcome.

Alter (1977) states that "interactive, conversational decision support systems --- are neither interactive nor conversational in any 'interesting' sense of the words." He bases this on a series of interviews concerning 56 different

systems. Alter says "If managers have neither the time nor the inclination to learn the assumptions and practical details underlying a decision support system, then they should be encouraged to use it only through intermediaries who do understand the details."

Martin (1973) observes that because unstructured problems are complex and because users will not be inclined to use a computer terminal, a specialized third party should be employed to operate the system.

Carlson and Sutton (1974) reported some interesting behavioral observations from a case study of the introduction of five San Jose police officers to GADS, an interactive system for problem solving. None of the subjects had any knowledge of computer programming. The authors reported that the users initially did not expect to operate the system, but once they became familiar and competent they preferred operating the system themselves. Carlson and Sutton also observed that users had important time constraints for introductory training. Too long training sessions at first were mentally demanding, caused loss of interest and were not consistent with the way the users normally operate. Forgetting set in when too long a period elapsed without a training session (almost two weeks). But by the end of the case-study, one or two weeks between sessions did not appear to cause forgetting. The

users stated a strong need fcr involvement to: verify and explore data, fcrmulate and modify problem-solving procedures, observe the results cf procedure execution, and provide intuitive insight which cannot be verbalized or quantified.

The important pcint seems to be the involvement of the users. Involvement of managers during implementation seems central to their change prccess.

One key questicn may be, wculd direct operation or the use of a specialized third party to operate the MIS terminal produce improved learning perfcrmance and attitudes during system implementaticn?

2.7 Summary

This chapter examined a good deal cf research and theory cn decisicn makers and their use of information systems. A behavioral perspective was taken because of the complexity of decision making in a dynamic environment when the man-machine interface is not well understood.

First a significant framewcrk for research in MIS was presented. It and others like it have been the basis for a considerable amount of MIS research. The framework attempted to describe and relate the major variables affecting decisicn makers in their use cf information systems and the resulting performance. Finally, the framework served as the foundation fcr this research.

The second sectien discussed success of MIS implementation. The literature review showed that many authors viewed the implementation period as critical to decision maker's later acceptance and use of the MIS. The implementation is a learning and trial period. If the decision makers see improvements in their performance effectiveness during their learning period, if they can be made receptive and willing to use the MIS, then the change process should lead to future use, thus success of the MIS.

The decision envircnment was analysed in Section 2.3. Theory was presented on the level and structure of decision making. The sectien concluded that investigation into the success of MIS should be ccncerned with operational and managerial control levels.

The next section fccused on the decision maker. Research was presented cn his attributes, behavior and MIS use. Direct acquired attributes, attitude and experience, were separated from the indirect ones of aptitude and style. The findings stress the importance of these components on MIS use, user satisfactien and decision effectiveness. One possible counter intuitive idea emerged. That is, while an MIS is expected to improve decision making efficiency, the opposite may be true during learning and implementation. During the transition a longer time spent problem finding and deciding may be coincident with imprcved performance and willingness to use the MIS in the future. If decision making efficiency is lcwered during the learning and change process, it may be difficult tc predict or judge the transitory impact on attitude and ccnfidence.

Section 2.5 discussed MIS characteristics. It noted that research concentratien on just MIS characteristics has not produced significant relationships with MIS usage. The section also presented scme generalizations about currently installed decision support information systems.

The last section of the chapter focused on certain environment conditions that may be of key importance during learning and implementation of an MIS. It first drew attention to the facilitator or change agent guiding the transition. It stressed concern for the functional orientation, number and role of the facilitators. The last section then discussed the possible problems with a decision maker learning to use an MIS and having to operate it at the same time. It raises the question of whether the use of a specialized third party to operate the MIS terminal during implementation would produce improved results.

None of the research surveyed explained most of the variance in the use of the MIS, or the performance or satisfaction of the decision makers when using it. Other variables not considered here will probably have causal effects on this process. But time and resources limit the extent of this study.

Lastly it may be helpful to restate and summarize some of the characteristics suggested by the theory and research before developing the research model.

The MIS must provide useful timely information which adds to a manager's store of knowledge. The key is to understand how a manager can optimize his use of such an MIS. Concentration must be spent on the man-machine interface. It is here that understanding is perhaps

weakest. Recall that both the decision-process and man-machine environment are complex, not wholly known, often unpredictable, and variable among managers. The managers are people with an array of attitudes, perceptions and resistance to change which are dynamic in management control MIS. The data are often delayed, incomplete and transformed into high levels of aggregation. The number and type of problems that must be found and solved vary continually. The people and technology change during the life of the MIS.

The MIS must permit selection, filtering, aggregation and display of key information in readily comprehensible form without undo delay. It must be adaptable to differing managers and their styles of operating. With decision making a function of insight, the MIS should provide browsing and manipulation of the data. The ability is needed to go back and forth between summary and detail data in pictorial and printed form, observing deviations and trends. The response time must be reasonable. Both manager and the system should be able to suggest things to look at. Most importantly, an effective and efficient MIS will couple the manager and the computer utilizing the unique capabilities of each with realizable benefits to the manager.

We can conclude this chapter with the following question: Should organizations build the large data bases, develop the expensive software, and install the hardware necessary tc support management control decision-making? Many elements of this are under way in a significant number of organizations. Yet the research has nct confirmed that an interactive data-based MIS will increase a manager's use of the system, his satisfaction or his perfcrmance with it. Juergens (1977) supports this question with his comment that "While numerous ccmputer-based infcrmaticn systems have been developed and are in operation there is nc unified or commonly accepted theory tc guide the development process."

From an MIS management perspective, Slotkin (1978) urges us not to abandon the advantages of integrated MIS. He is convinced that the problem lies in MIS implementation.

C H A P T E R I I I

THE RESEARCH MODEL

The first chapter asserted that information systems are not being used effectively to support decision making in organizations. This was the major issue influencing this research. Chapter I alsc attempted to present the dynamic complexity of the modern decisicn making environment, and the rapid advances in infcrmation systems technology.

In the second chapter, the state of the art in information systems research and theory were discussed. First a framewcrk fcr research in MIS was presented. Then a series of ideas, propositions and findings were analyzed which set the stage fcr this research.

This third chapter relates the general issues, theories and research reviewed in the previous chapters to the specific intent and design of the present research. This intent and design includes:

1. Developing a research model. The purpose of the research model is tc fcrmalize the concepts that were presented and to give structure to the research that was undertaken.

2. Designing a methcdology based upon the research model to collect and analyze the data.

3. Conducting and evaluating an experiment to test the research model and methcdology.

Thus it seems pertinent to ask how can we effectively couple a decision maker and a computerized information system tc improve the perfcrmance and process of decision making? What is needed is research which will help explain the process of learning and acceptance during implementation of an MIS. The MIS must prcduce adequate behavioral and performance effects to be accepted. The effects must be such that the manager is motivated to make continued use of the MIS to assist him in his decision making.

3.1 The Proposed MIS Research Model

This is a research study of the implementation and use of information systems in managerial control decision making. To understand this dynamic interface, we must identify the factors or conditions that influence a decision maker when he is learning to use the MIS. Specifically, which variables lead to earliest learning, best performance and most favorable attitudes and confidences. In essence, the implementation is a trial period, a trial during which the decision maker learns and explores the benefits of using the MIS before accepting or rejecting it as an aid to his decision making.

A number of authors have discussed factors that may affect managerial use of MIS. One group of factors is related to the quality and character of the MIS. These include the type of interaction with the user, output media and form, decision aids, etc. The information requirements would vary with the type and timing of problem finding and problem solving. Not just what information, but what level of detail, comparisons, control limits for inclusion and precision.

A second group of variables encompass the decision environment. Included would be the level, structure, importance and functional area of the decision. Organizational influence would be part of the environment,

such as upper management support and peer grour pressure. Economics enters here under cost/value considerations.

A third group of factors influencing managerial decisions to use an MIS are personal to the decision maker. These factors can be separated intc:

A. The attributes a decision maker possessed at birth or acquired thrcughcut his development. These factors would include his aptitude and decision style.

B. The attributes a decision maker acquired directly in the recent past. These factors would include his experience, attitude and decisicn confidence.

Research has cnly recently begun in these areas. Much of it is exploratory or suggestive. None of it has been able to explain most of the variance in MIS use.

Some of the more informative research (see the first two chapters) stressed attenticn to be paid to the behavioral issues in this situation. Let us look at MIS implementation and use from a behavioral perspective. The decision maker is the key tc MIS use for these purposes. However, Ackoff (1967) states that "Managers don't know what information they need." Dickscn and Powers (1973) adds that "they also do not know when they need information, through which medium they want it presented, or what fcrm it ought to take." They ccntinue, "In summary, the contentions suggest that a large number of variables unknown to either the manager/user or the systems designer have a substantial influence on information system usage."

When deciding to use an MIS, a decision maker is affected by his experience, cognitive style, organizational pressure and the decision envircnment; as well as by the information system and information available. These decision makers have learned ways of dealing with their work environments which have usually worked, but do not generally involve using MIS. Learning theory tells us that people tend to use methods that were successful for them in the past. They also rely on ccmmunications frcm others and observations of what are useful. But there are few successful management informaticn systems. It is not surprising then that managers are reluctant to change their ways and use an MIS.

Time is often said to be a manager's most precious commodity. Managers are beset by time pressures from competing needs. They usually receive information sporadically and in bits and pieces. They therefore go through their days devcting relatively brief time periods to each decision situation before moving on. If a decision requires more information or analysis, the task is often delegated tc a subcrdinate tc gather the information, or do the analysis. Therefore, it may be unrealistic to develop information systems which expect direct managerial interactions.

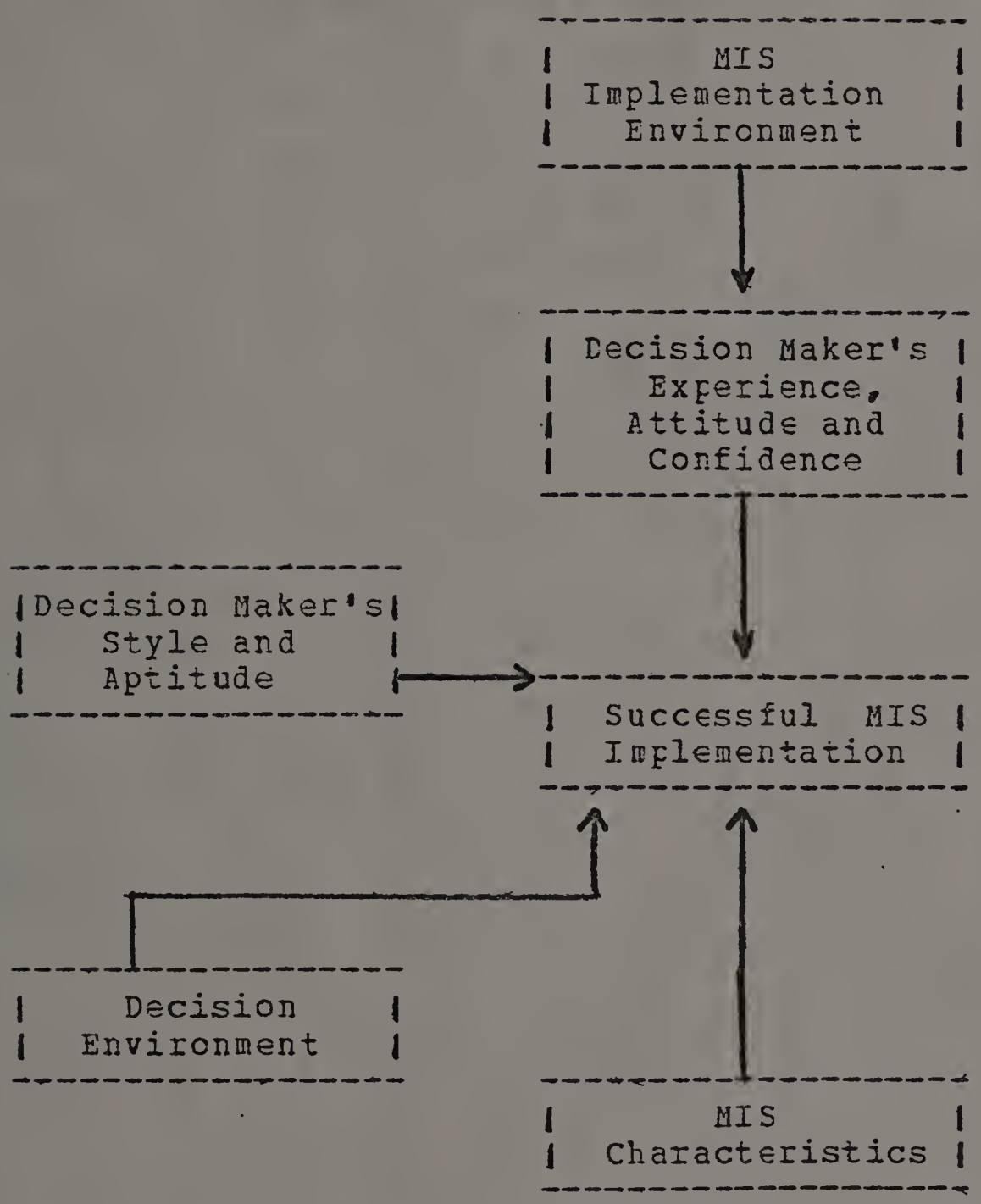
Simon (1966) suggests that most managers satisfice rather than optimize. Leavitt (1975) says that managerial problem finding with the aid of simple heuristic rules may cost much less than applying elabcrate, formal, analytical optimization methods. If managers operate this way and put a low value on the impact cf new information, they will make little use of MIS.

Suppose the abcve summary is realistic. Then how can successful implementaticn of MIS be accomplished? Perhaps first by paying more attentiон to the learning and change process in getting managers to use an MIS. Secondly by allowing managers tc gc through the learning process more in the style to which they are accustomed. These factors can be grouped together into a class of variables called the MIS implementation cr learning environment. Through the conditions set up in this implementation environment, a decision maker's experience, attitude and confidence is shaped. These directly acquired attributes should then exert a strong influence on a decision maker's future use of an MIS.

All these classes of variables are put together to develop the MIS research model. This model is shown in Figure 3.1.

FIGURE 3.1

THE MIS RESEARCH MODEL



3.2 The Independent Variables

The last section concluded that it may be the factors in the implementation environment that provide the sufficient conditions for successful MIS implementation. Therefore, it is to the implementation environment that we now turn to look for the variables to be examined in this study.

The goal of the implementation environment is to produce favorable experiences and attitudes during learning and introduction of the MIS. The establishment of favorable experiences and attitudes during learning should carry over so decision makers are inclined to use their management information systems in the future. This is a change process.

Change is often resisted. It is resisted because of fear of failure and fear of the unknown. As managers learn to use the new information systems they may make a number of mistakes and may make less effective decisions than they otherwise would have made. To overcome these influences the managers must feel supported and encouraged as they learn. The managers must place confidence in the people and methods helping them with the transition. The managers must develop favorable perceptions and attitudes until they can see positive results in their decision effectiveness.

3.21 Facilitator orientation and number. The key to the change process may be the facilitator or change agent, a skilled individual who guides the transition. The systems analyst is often the facilitator for change to most MIS. However the analyst's perceptions and functional orientation are usually quite different from the decision maker's. Unless the analyst is quite skilled in the change process he may use a change strategy which inhibits rather than promotes successful change to using the MIS. On the other hand, selection of a facilitator whose primary role has been as a user presents other potential problems. Unless the facilitator is quite experienced with the MIS, he may not be knowledgeable enough or sufficiently convinced of its merits to overcome other decision makers' resistance to change. Perhaps the best change strategy is to use a facilitating team. This team might be composed of two types of people, one whose concern and orientation is most like the decision maker's, and the other most like the systems analyst's.

3.22 Terminal operation: direct or indirect. In addition, managers may feel more inclined to learn and use an MIS if they can learn by using methods and a style to which they are accustomed. Their ability and eagerness to learn to use an MIS in problem finding and analysis may be diminished if they must also concentrate on learning and remembering terminal operation and MIS specifications. Managers often

delegate the tasks of machine cperation and information gathering. Therefore, they may be more inclined to learn to use an MIS if they have scme skilled assistance with the computer terminal cperation. With experience, managers may develop the competence and confidence tc overcome this limitation. After gaining some competence and confidence in learning to use an MIS, some managers may enhance their eagerness and confidence in learning by directly operating the terminals.

What is important, is managerial involvement. To overcome managerial resistance to change, managers must become receptive tc the new methods. By making managers active participants in their learning during the implementation of the MIS, their resistance should be diminished and their attitudes mcre open to change. When managers directly operate the ccmputer terminals they become active in their learning envircnment. In addition, many people are enthusiastic cver the feeling of being in direct physical control of a machine's operation.

Perhaps the best change strategy is to have a decision maker operate the terminal himself during learning. For this strategy to succeed, cperation of the system must be easy to learn and remember. It is probably important to have ready suppcrt frcm the facilitator or a skilled operator to assist the decision maker in correct operation.

This will help build a bridge of support and positive response.

If the system is difficult to learn and remember, or there is a long time between learning sessions, or a manager's time is quite limited, then perhaps the best change strategy is to have a skilled terminal operator function as an intermediary between the decision maker and the MIS during early learning. After a degree of learning has taken place the managers should be given the choice to continue to use the operators or operate the terminals themselves. In this way, the managers should be able to maintain more of their present style, exert the degree of physical control they desire and spend their time on the functions they view as important.

3.23 Experimental grouping of the independent variables. This research study tested the effect of these three variables:

1. functional orientation of facilitators,
2. number of facilitators, and
3. direct terminal operation versus use of a skilled intermediary,

on the learning and use of MIS in support of managerial decision making. Specifically, each variable was tested as follows:

- Functional Orientation and Number of Facilitators

The use of three types of facilitators:

1. The first is viewed as an outsider to the decision maker. That is a person whose role and functional orientation is based upon control, audit and efficiency of use; such as the typical systems analyst.

2. The second is a facilitatcr whose orientation is similar to the decision maker's. That is a person whose primary ccncerns are the decisions and the effects of decision making using an MIS. The facilitatcr would cnly be secondarily concerned with efficiency and the use of the MIS.

3. The third type of facilitator is a team composed of two people. One member's functional orientation would be similar to the decision maker's, and the other member's similar to the systems analyst's.

- Direct Terminal Operation vs. Use of a Skilled Intermediary

1. The decisicn maker directly operating the computer terminal.

2. Initial use of a skilled intermediary to operate the terminal, then the decision maker's chcice to continue using the intermediary cr to operate the terminal himself.

These independent variables produce six experimental groups which are illustrated in Figure 3.2.

FIGURE 3.2

INDEPENDENT VARIABLES TO BE TESTED

		Terminal Operation	
		Direct by Decision Maker No Choice	Start Through Intermediary Then Choice of Direct or Intermediary
Facilitator and Number and Orientation	One Person Outsider and System Oriented		
	One Person User and Decision Oriented		
	Two People One With Each Orientation		

3.3 The Dependent Variables

The managerial decisicn process is still a subject about which much is unknown. We don't kncw why or when a manager will use a particular approach, methcd, or tool to assist him in his decisicn making. This has certainly been true for the use of management infcrmation systems. Despite the considerable effort spent cn MIS, most have not been successful, as noted earlier in this paper. But success is not a very precise criterion. It is difficult to quantify and measure success. What is usually meant by a successful MIS? Lucas states that "If a system is not used, it cannot be considered a success even if it functions well technically." (pp 3, Lucas 1975) It seems reasonable to conclude that for an MIS tc be successful it must motivate a manager to make ccntinued use cf the system to assist him in his decision making. Many authcrs argued that information systems should improve decision making perfcrmance to be considered a success. What then are the criteria that should be used tc evaluate the effects of the independent variables?

3.31 Decision effectiveness. Decision effectiveness is most often associated with profitability in a business organization. It is alsc described as movement toward some quantifiable goals. Therefore scme component or measure of profitability should be cne of the dependent variables.

Ancther way tc lcck at effectiveness during MIS implementation is the effect on learning. That is, what learning is taking place and at what rate. An individual learning to use a new technigue cr process to support his decision making is mentally giving the process a trial. After some period of time using the process the decision maker may reject the process as an aid to his decision making, or begin to accept it. The time to rejection may be reasonably short. Faster rates of learning may reduce rates of rejection. If faster improvements in performance are taking place under certain experimental conditions than under cthers, perhaps there is a differential in learning also taking place. This faster rate of improvement in perfcrmance or differential learning impact may cause the decision maker to accept the MIS sccner or at least extend his trial period tc decision. For this reason, the rate of improvement in perfcrmance scores was also chosen as a dependent criterion.

3.32 Behavicral criteria. Dickson and Powers', Sollenberger's and Lucas' research all found that user satisfaction with the MIS and inclinaticn to use the MIS in the future, are major criteria of the success of an MIS. Therefore, increases in user satisfaction and inclination to use the MIS in the future should be criteria for measurement of MIS success. These then were measures used in this

study.

3.33 Decision confidence. A manager going through a learning and change environment is evaluating the techniques and processes he is learning. His natural initial reaction is some degree of suspicion and resistance. One measure of his satisfaction, acceptance and willingness to use the new technique is the manager's confidence. A manager who is more confident after completing the learning environment should be more likely to make use of an MIS after returning to his regular job.

However one of the first steps in the change process is the giving up of reliance on existing methods and attitudes. When a decision maker changes from using present methods to trying new ones, his confidence may decrease. He is giving up the old ways he is familiar with and learning new ones. While learning the new methods, a decision maker probably feels an increased risk of performing poorly. He probably will be somewhat confused by the new system and information provided. This increased feeling of risk and confusion will probably result in a lower confidence. Thus it seems reasonable that confidence may be inversely related to attitude change and the willingness to try new methods during the early stages of implementation. Decision confidence was selected as a dependent variable.

3.4 The Hypotheses

This report began by discussing information systems and related areas. It made the assertion that information systems are not being used effectively tc support decision making in organizations. The brcad research question was raised: what factcrs or conditions will cause decision makers to make more effective use of MIS and be more willing to use them in the future? After reviewing relevant literature, the focus cf inquiry was narrowed and a descriptive model was proposed. In some sense this phase of the study culminated here with the statement of the specific propcsitions that were tested.

The first series cf hypotheses dealt with the number and functional orientation of the facilitatcr(s), the person or people guiding the decision maker's learning and change to using an MIS for decisicn support. The facilitators' functional orientation were dichotcmized so each was viewed as either:

A. similar tc the decisicn maker, or

B. a systems specialist and an outsider.

These hypotheses were:

1. Decision makers will have greater effectiveness, when facilitated by a team of two, one of type A and the other of type B, than when facilitated by one person of either type A or B.

2. Decision makers will have greater effectiveness when facilitated by one person of type A than

by one person of type B.

3. Decision makers will have greater initial rates of improvement in effectiveness when facilitated by a team of two, one of type A and the other of type B, than when facilitated by one person of either type A or B.

4. Decision makers will have greater initial rates of improvement when facilitated by one person of type A, than by one person of type B.

5. Decision makers will be more inclined to use an MIS in the future when facilitated by a team of two, one of type A and one of type B, than when facilitated by one person of either type A or B.

6. Decision makers will be more inclined to use an MIS in the future when facilitated by one person of type A than by one of type B.

7. Decision makers will have more positive attitudes toward their MIS when facilitated by a team of two, one of type A and one of type B, than when facilitated by one person of either type A or B.

8. Decision makers will have more positive attitudes toward their MIS when facilitated by one person of type A than by one person of type B.

9. Decision makers will have greater confidence in their decision quality, information supplied, and facilitator's assistance when facilitated by a team of two, one of type A and one of type B, than when facilitated by one person of either type A or B.

10. Decision makers will have greater confidence in their decision quality, information supplied, and facilitator's assistance when facilitated by one person of type A than by one person of type B.

The second series of hypotheses dealt with who operated the computer terminal to input and output data during implementation. This function was also dichotomized into

either:

A. Direct terminal cperation by the decision maker throughout the implementation,

B. or, initial use of a skilled intermediary to operate the terminal, then the decision maker's choice to continue using the intermediary or to operate it himself.

These hypotheses were:

11. Decision makers will have greater effectiveness with A than with B.

12. Decision makers will have greater initial rates of improvement in effectiveness with A than with B.

13. Decision makers will be more inclined to use an MIS in the future with A than with B.

14. Decision makers will have more positive attitudes toward their MIS with A than with B.

15. Decision makers will have greater confidence in their decision quality, information supplied, and facilitator assistance with A than with B.

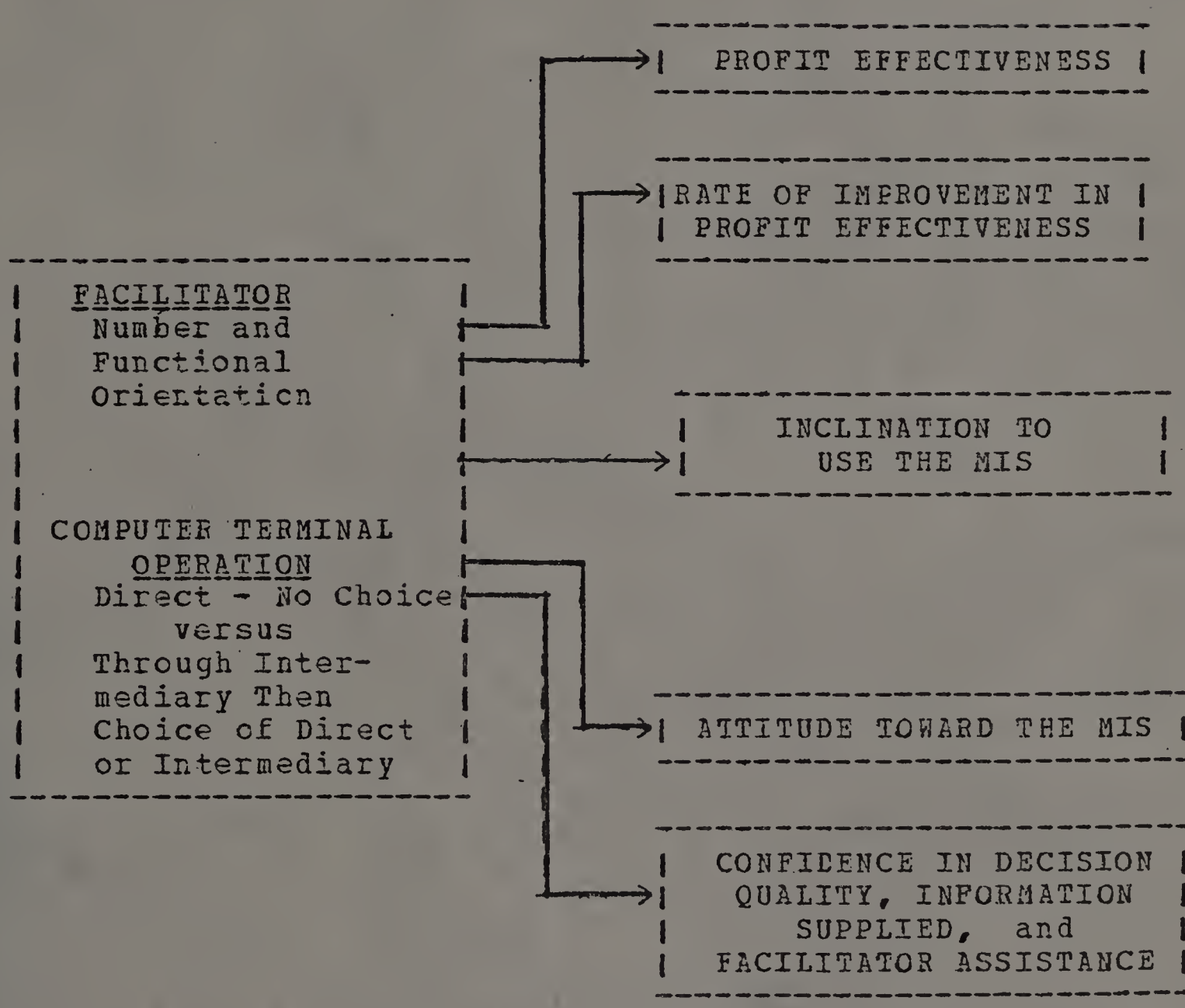
3.5 A Model of the Research Propositions

The preceeding sections formalized the implementation variables in the MIS. The independent and dependent variables were operationalized. The independent variables were ones that may have a significant effect on acceptance and future MIS use. The dependent variables were measurable and should reflect MIS acceptance, use and effectiveness. The variables were defined so as to be testable in this experiment and to be generalizable to the world at large.

The relationship between the variables were stated in a series of 15 hypotheses. These propositions are presented pictorially in Figure 3.3.

FIGURE 3.3

A MODEL OF THE RESEARCH PROPOSITIONS



3.6 Research Model of the MIS Implementation Environment

This chapter related the issues, theories and research reviewed in the first two chapters to the specific intent and design of the research. In doing this, the chapter formalized the concepts that were presented, focused the issues that were examined, and structured the research that was undertaken.

After the research objectives of this study were stated, this chapter presented a complete model for research in MIS. This model included the major classes of variables that have effects on managerial acceptance and use of management information systems.

The study then turned to focus on the MIS implementation environment. Specifically, the impact of that environment on the decision maker's experience, attitude and confidence. These decision maker attributes were presented as being a significant class of factors affecting the decision maker's acceptance and future use of the MIS.

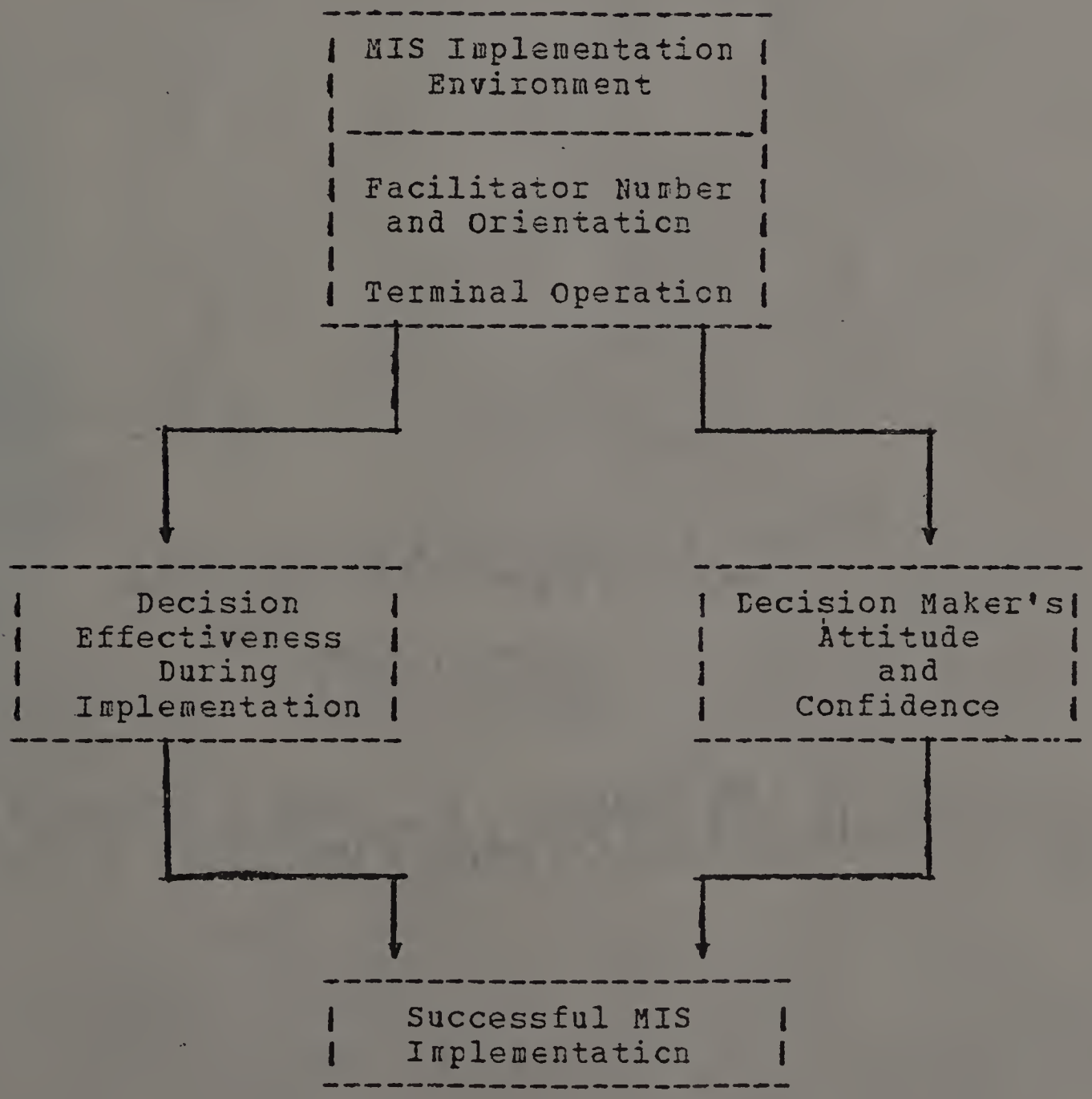
This research was structured by specifying:

1. The independent variables and their experimental grouping.
2. The dependent variables that should be measured.
3. The hypotheses that are proposed.

The essence of this research theory and structure is presented in the model in Figure 3.4.

FIGURE 3.4

RESEARCH MODEL OF THE MIS IMPLEMENTATION ENVIRONMENT



C H A P T E R I V

METHODOLOGY

In Chapter 3 the issues, theories and questions were narrowed and focused. A model was presented for research in the MIS implementation environment. This chapter describes the experiment and data collection that was used to test those hypotheses. The design produced data of the type, form and amount that permitted testing the hypotheses, drawing inferences at reasonable levels of significance, and generalizing to environments beyond the one being used. The experiment contained adequate control to insure a high degree of internal validity. The experiment was conducted within the limited resources that were available.

To conduct research which does not violate the canons of scientific procedure while producing results which are generalizable to a wider context requires that the design have high validity.

External validity centers on generalizability. It depends upon the similarity of the experimental and real world situations. Greater external validity is achieved as representativeness of the laboratory environment increases. Of particular importance is the realism and complexity of the simulated environment and the similarity of the conditions and subjects in the Game to their real world

counterparts. These factors relate to the design of the simulator, the participants, and the facilitators.

Internal validity is concerned with whether the experimental manipulation made a significant difference. High internal validity means a high degree of assurance that the treatment variables in the experiment actually caused the observed results. It implies that if the experiment was replicated the same results would be observed. Among the more important factors in this study are the procedures used for the formation of the experimental conditions, the participant assignment methods, the data collection procedures, and the type and quality of measures taken.

4.1 The Management Game

Both a laboratory environment and an ongoing organization were considered for this research into the learning and use of MIS in managerial decision making. In a laboratory environment conditions can be created and controlled to isolate the variables. However, some of the reality and dynamics of decision making are lost by bringing it under study in a laboratory. On the other hand, creating the conditions desired and controlling for other influences becomes difficult when studying an ongoing organization.

In order to control conditions, isolate the effects of specific interface factors and establish a method to measure decision performance, a laboratory experiment was run. Good research methodology can most easily be developed and perfected in a laboratory. With good methodology the specific interface factors can be tested and confirmation obtained for their effects. Then the methodology can be taken out and tested under more realistic conditions.

The type of laboratory experiment used was a management game. Conducting the experiment was synonomous with allowing each decision maker to play the game for 21 periods to generate the data needed. A number of such games have been developed and used to carry out research in MIS. Chervany, Dickson and Kozar (1972) discuss the advantages of adopting the experimental gaming approach to studying

information systems support for management decision making.

In this experimental setting, the effects of the independent variables were measured by three criteria: decision effectiveness, decision ccnfidence and the perceptions and attitudes of the decision maker. Significance on any measure would be desirable. Significance on more than one measure would strengthen support for causality.

4.11 Decisions in the game. The specific game that was used is called PROSIM. PROSIM is a game designed to simulate a decision environment in prcduction management. In the game, the decision makers were required tc schedule three products on two production lines; order and expedite raw material; hire, assign, train, layoff and fire workers; and expend funds for quality ccntrcl and maintenance. Tables 4.1 and 4.2 are samples of the output from PROSIM.

TABLE 4.1

SAMPLE DECISION INPUT

DECISION SUMMARY, PERIOD 16:

QUALITY CONTROL EXPENDITURES: 300.

PLANT MAINTENANCE EXPENDITURE: 501.

REGULAR RAW MATERIALS ORDER (UNITS): 0.

EXPEDITED RAW MATERIALS ORDER (UNITS): 0.

LINE 1

MACHINE	OPERATOR	PRODUCT	SCHED. HOURS
1	13	X	12.
2	4	Y	12.
3	3	Z	12.
4	2	Z	12.

LINE 2

MACHINE	OPERATOR	PRODUCT	SCHED. HOURS
1	18	Z	12.
2	7	Y	12.
3	1	X	11.
4	26	Z	12.

* = TRAINING THIS PERIOD.

ARE THESE DECISION VARIABLES CORRECT?
(TYPE YES TO BEGIN SIMULATION, NO TO CHANGE VARIABLES).
YES

TABLE 4.2

SAMPLE PERIOD OUTPUT

P R O S I M
P E R I O D 16 F I R M 3

C O S T I N F O R M A T I O N

	COSTS FOR PERIOD			
	X	Y	Z	TOTAL
LABOR	80.	84.	168.	332.
MACHINE SET-UP	0.	0.	0.	0.
MACHINE REPAIR	0.	100.	0.	100.
RAW MATERIAL	731.	1015.	2419.	4165.
EQUIPMENT USAGE	230.	240.	480.	950.
INT INV CARRYING COST	17.	21.	40.	78.
FIN INV CARRYING COST	31.	22.	71.	124.
DEMAND PENAITY	0.	0.	0.	0.
TOTAL	1089.	1482.	3178.	5748.
QUALITY CONTROL				300.
PLANT MAINTENANCE				501.
TRAINING COST				0.
HIRING COST				0.
LAYOFF AND FIRING COSTS				0.
RAW MATERIAL CARRYING COST				63.
ORDERING COST				0.
FIXED EXPENSE				300.
TOTAL				1164.
TOTAL COSTS				6913.
EFFICIENCY RATINGS				1.048

	CUMULATIVE COSTS			
	X	Y	Z	TOTAL
LABOR	973.	701.	2014.	3688.
MACHINE SET-UP	0.	0.	15.	15.
MACHINE REPAIR	600.	500.	1100.	2200.
RAW MATERIAL	7246.	8131.	26972.	42350.
EQUIPMENT USAGE	3080.	2260.	6150.	11490.
INT INV CARRYING COST	223.	175.	506.	907.
FIN INV CARRYING COST	284.	282.	706.	1274.
DEMAND PENALTY	51.	0.	0.	51.
TOTAL	12463.	12054.	37462.	61975.
QUALITY CONTROL				4350.
PLANT MAINTENANCE				6654.
TRAINING COST				1100.
HIRING COST				550.
LAYOFF AND FIRING COSTS				155.
RAW MATERIAL CARRYING COST				2530.
ORDERING COST				920.

TABLE 4.2 - continued

I N V E N T O R Y I N F O R M A T I O N

RAW MATERIALS

BEGINNING INVENTORY	ORDERS RECEIVED	USED IN PRODUCTION	ENDING INVENTORY
9111.	0.	4900.	4211.

RAW MATERIALS ORDERS OUTSTANDING

PERIOD DUE	TYPE	AMOUNT
18.	REG.	2500.

INTERMEDIATE INVENTORIES

	BEGINNING INVENTORY	USED IN PRODUCTION	PRODUCTION THIS PERIOD	ENDING INVENTORY
X	647.	641.	859.	865.
Y	534.	433.	597.	698.
Z	1000.	954.	949.	995.

FINAL INVENTORIES

	BEGINNING INVENTORY	PRODUCTION THIS PERIOD	DEMAND THIS PERIOD	ENDING INVENTORY
X	416.	626.	0.	1042.
Y	7.	423.	0.	430.
Z	88.	932.	0.	1020.

D E M A N D I N F O R M A T I O N

	DEMAND PER 18	CARRYOVER FROM PER 15	TOTAL DEMAND PER 18	DEMAND PER 21
X	2420.	0.	2420.	1750.
Y	1033.	0.	1033.	1200.
Z	2373.	0.	2373.	1350.

The purpose here is nct to discuss all the details of the Game, but to present scme important and relevant features for this research. Althcugh brief, it is sufficient for evaluating the specific issues relating to the hypotheses testing and validity of this study.

In the Game the participants acted as middle level decision makers. Their decisicn prccesses involved a set of sequentially interdependent decisions tc meet profit objectives. The decisions were made under conditicns of limited information and decision support in an uncertain environment. Decision tasks in the Game were inherently complex. No randcmizing was used tc generate data. Nor was there any easily discovered path tcward an optimum solution. The decision tasks seemed to resemble those that would be encountered in a real prcduction environment.

4.12 Promotion of realism. A number of steps were taken to further promote realism and insure that the subjects maintained their interest and tried their best. These included:

1. Awarding prizes to the four participants with the highest efficiercies at the end of the game.

2. Awarding prizes tc the four participants who achieved the greatest increase in efficiency from period nine to the end of the game. This was announced after pericd nine had ended.

3. Counting the efficiency in the game in calculating the subject's grade for the course.

4. Assuring that there was ncthing in the game

that permitted any team to go way out ahead.

5. Interviewing past participants in the game and examining past results to eliminate any potential confounding of the results.

4.13 Scoring in the game. Management games usually contain a profit or total cost as the game score. For this experiment total cost was used to evaluate decision effectiveness. More specifically, cost efficiency was the measure that is used. Cost efficiency is the ratio of standard cost for the quantity produced to actual cost incurred. Cost efficiency is closely related to cost variance, a very common measure of performance in actual production environments. Efficiency was chosen because it eliminated the effect of production volume changes on the size of the variances.

The cost efficiency for each period and cumulative for each subject was calculated by the computer at the end of each period. It was printed along with the other data, Table 4.1. The cost efficiencies served as the measures of decision effectiveness, see Section 3.31.

The Game is installed at the University of New Hampshire. The computer programs are stored and run on the University's DEC-10 computer. On-line terminal operation of the Game was conducted in the computer terminal room of McConnell Hall, which houses the Whittemore School of

Business and Economics.

PROSIM has been used as a teaching aid for two years, for undergraduate and graduate students in production management courses, at the University of New Hampshire.

4.2 The Subjects

4.21 Selection and assignment. The subjects were undergraduate students taking production management in the Whittemore School of Business and Economics at the University of New Hampshire. Seventy-eight students began as participants in the experiment. The students were randomly assigned to the six experimental groups, illustrated in Figure 3.2. Random assignment should have taken care of problems that might have occurred due to differing intellectual ability, decision styles, and attitudes among the subjects.

4.22 Prior attributes. Data on the subjects' aptitudes, experience with computers, and attitudes were gathered. This data was gathered for potential inclusion as covariates in the analysis. Aptitude data included course grade and grade point average. Experience and attitude data was gathered from a questionnaire administered before the experiment was begun, see Figure 4.1.

FIGURE 4.1

PROSIM QUESTIONNAIRE

Name_____ Section No. _____

Below is a series of statements. Each reflect a characteristic of computer information systems. They concern your experience, the facilitators or people who will assist you in learning and using PROSIM, the game, and your willingness to use such systems.

Please rate each statement by circling one number to the right of each statement.

		EXPERIENCE				
1.	Rate your experience with computer terminals. (If your experience is in Admin. 424, rate = 1.)	None 0	1	Some 2	3	Great 4
		ATTENTION				
	Rate the amount of attention the facilitator should pay to:	None		Some		Great
2.	The quality of the computer information system (PROSIM).	0	1	2	3	4
3.	The effectiveness of the students' decisions in PROSIM.	0	1	2	3	4
4.	The efficiency of the computer system's use in PROSIM.	0	1	2	3	4
5.	Saving the students' time during playing PROSIM.	0	1	2	3	4
6.	The students' feeling about the computer system.	0	1	2	3	4
7.	The students' suggestions about the computer system.	0	1	2	3	4
8.	The students' getting the highest possible scores in PROSIM.	0	1	2	3	4
9.	How the students use the information in their decision making.	0	1	2	3	4
10.	How the students use the computer.	0	1	2	3	4

FIGURE 4.1 - continued

Rate how important it is to you that the facilitator:	IMPORTANCE None		Some		Great
11. Is an expert in how the computer system works.	0	1	2	3	4
12. Helped develop PROSIM.	0	1	2	3	4
13. Works in developing computer information systems.	0	1	2	3	4
14. Is a student.	0	1	2	3	4
15. Is supportive of the students' learning process.	0	1	2	3	4
16. Is sensitive to student problems with PROSIM.	0	1	2	3	4
17. Is sensitive to demands on students' time.	0	1	2	3	4
18. Is a skilled communicator.	0	1	2	3	4
19. Is easy to talk to.	0	1	2	3	4
20. Is adaptable to each students' needs.	0	1	2	3	4
21. Promotes a close working relationship with each student.	0	1	2	3	4

	IMPACT None		Some		Great
22. Rate the impact you expect the facilitator to have on your performance in PROSIM.	0	1	2	3	4

Rate your willingness to use computer information systems to assist you in:	WILLINGNESS None		Some		Great
23. Your decision making in PROSIM.	0	1	2	3	4
24. Your decisions in your future jobs that are similar to PROSIM.	0	1	2	3	4
25. Any decision you have to make in your future jobs.	0	1	2	3	4

4.23 Post attitudes. User satisfaction and inclination to use the MIS are attitudinal and intentional in nature. Therefore, they were measured through a questionnaire given to the subjects after the experiment was completed.

The subjects were given a brief written scenario, see Figure 4.2. The scenario asked them to assume that their jobs were similar to the roles they took in the experiment, production control supervisors. It also presented them with the possibility of installing a computerized information system to assist in their decision making.

The subjects were asked to answer five questions relative to the scenario, see Figure 4.3. Four questions related to their inclination toward such a computer information system. These asked their inclination to:

1. use,
2. learn more about,
3. have an outside facilitator assist their learning to use,
4. operate a computer terminal themselves to use,

such a system. The fifth question asked what change they would expect in their job performance from using such a system.

The answers to each question was used as a dependent measure, as well as a composite score.

FIGURE 4.2

MIS QUESTIONNAIRE SCENARIO

Name_____

Please read the following paragraph, then answer the questions.

Assume that after graduaticn you got a job as a production control superviscr for the local General Electric plant. In your job you are responsible for scheduling four products on six production lines. Each prcduct goes through operations on five machines before moving into finished goods inventory. To finalize the prcduction schedule you have to gain the agreement of the production supervisor, who supervises the machine cperators; the quality control supervisor, who supervises inspecticn and maintenance; and the purchasing agent whc buys the raw material. You get weekly reports of customer crders and sales forecasts from the marketing departments.

After working at your scheduling job for six months, the parent company has offered to install a computerized information system in your plant to assist you with your scheduling jcb. Ycur boss, the production manager, and the plant manager have agreed to install the system if you want it and will use it. They have asked ycu to answer the following questicns in connecticn with your decision.

FIGURE 4.3

MIS QUESTIONNAIRE

1. How inclined would you be to use such a computer information system to assist you in your scheduling job?

Opposed	Inclined Against	Neither Eager Nor Opposed	Inclined In Favor	Eager
0	1	2	3	4

2. How inclined would you be to learn more about such a computer system?

Opposed	Inclined Against	Neither Eager Nor Opposed	Inclined In Favor	Eager
0	1	2	3	4

3. How inclined would you be to have an outside consultant/facilitator assist you in learning to use such a computer system?

Opposed	Inclined Against	Neither Eager Nor Opposed	Inclined In Favor	Eager
0	1	2	3	4

4. How inclined would you be to operate a computer terminal yourself versus using a terminal operator, to schedule and get information you need?

Opposed	Inclined Against	Neither Eager Nor Opposed	Inclined In Favor	Eager
0	1	2	3	4

5. If you used such a computer system, what change would you expect in your job performance?

Significant Worsening	Moderate Worsening	No Change	Moderate Improvement	Significant Improvement
0	1	2	3	4

The next three questions relate to your confidence if you learned and used such a computer. Please mark the appropriate point on each scale.

FIGURE 4.3 - continued

6. How confident would you be in the quality of your decisions?

(Confidence in %)

0 10 20 30 40 50 60 70 80 90 100%

7. How confident would you be that the information supplied by the computer system is of assitance to you in your decision making?

(Confidence in %)

0 10 20 30 40 50 60 70 80 90 100%

8. How confident would you be in the facilitator's assistance to your early learning and improved decision making using the computer system?

(Confidence in %)

0 10 20 30 40 50 60 70 80 90 100%

4.24 Decision confidence.

Decision confidence was used as a dependent measure. Confidence was measured through the questionnaire given to the subjects after the experiment was completed. The questionnaire related to the scenario, see Figure 4.2.

The subjects were asked to answer three questions, see Figure 4.3. These were:

1. His confidence that the learning environment is beneficial.

2. His confidence that the information supplied by the computer system will be of assistance to him in his decision making.

3. Perhaps most importantly of all, his confidence in the quality of his decisions.

A composite score was also compiled and tested.

4.3 The Facilitators

4.31 Their background. The facilitators were selected, trained and characterized to fill the experimental roles. They were participants in the game in the prior semester. The student who portrayed the systems analyst type actually did computer programming and develcpment wcrk on the game. He was respcnsible for ccmputer maintenance of the game before and during this experiment. The student who portrayed the user decision orientation is a person who is skilled and specializes in organizational behavior training and development.

4.32 Their training. The facilitators went through a period of training tc insure that they modeled the desired behavior. They were provided with a series of methods to follow and statements tc make tc the subjects to insure that they portrayed the desired characteristics.

Each facilitator made a trial presentation before separate sample grcups cf students whc were not subjects in the experiments. After the trial presentation, the sample group of students critiqued the facilitator's style and role. The trial presentaticns were video taped. The video tapes were critiqued by the facilitators, an expert in behavioral process and change, and the author.

4.33 Their rcle. The facilitatcrs conducted introductory sessions with the subjects. Each student went through the intrcductory session with cther subjects in the experimental group to which he was assigned. The facilitators conducted three follow up sessions with the subjects. One was held after each of the first two periods of the game; the third session came after the sixth period of the game.

The facilitatcrs were video taped during the intrcductory sessions. A new sample grcup of students were gathered, ones who were nct participating in the experiment and who had not seen any facilitator presentation. This group viewed the video tapes of the introductory sessions and evaluated the roles and styles of the facilitators by completing a questicnnaire, see Figure 4.4. This new sample group was divided intc twc groups, half viewing each facilitator first.

FIGURE 4.4

PROSIM FACILITATOR QUESTIONNAIRE

Below is a series of statements. Each reflects a characteristic of the facilitator or person who assisted the students in learning and using PROSIM, a decision making business game using a computer information system.

Please rate the facilitator by circling one number to the right of each statement.

Rate the amount of attention the facciliator paid to:	ATTENTION None		Some		Great
1. The quality of the computer information system (PROSIM).	0	1	2	3	4
2. The effectiveness of the students' decisions in PROSIM.	0	1	2	3	4
3. The efficiency of the computer system's use in PROSIM.	0	1	2	3	4
4. Saving the students' time during playing PROSIM.	0	1	2	3	4
5. The students' feeling about the computer system.	0	1	2	3	4
6. The students' suggestions about the computer system.	0	1	2	3	4
7. The students' getting the highest possible scores in PROSIM.	0	1	2	3	4
8. How the students use the information in their decisions.	0	1	2	3	4
9. How the students use the computer.	0	1	2	3	4

FIGURE 4.4 - continued

Rate the degree to which the facilitator demonstrated the follcwing characteristics:		ABILITY None		Some		Great
10.	Being an expert in hcw the computer system wcrks.	0	1	2	3	4
11.	Having helped develop PRCSIM.	0	1	2	3	4
12.	Working in developing computer information systems.	0	1	2	3	4
13.	Being a student.	0	1	2	3	4
14.	Being supportive of the students' learning process.	0	1	2	3	4
15.	Being sensitive to student problems with PROSIM.	0	1	2	3	4
16.	Being sensitive to demands on students' time.	0	1	2	3	4
17.	Being a skilled communicatcr.	0	1	2	3	4
18.	Being easy to talk tc.	0	1	2	3	4
19.	Being adaptable to each students' needs.	0	1	2	3	4
20.	Promoting a close wcrking relationship with each student.	0	1	2	3	4

		IMPACT None		Scme		Great
21.	Rate the impact ycu expect the facilitator to have cn students' perfcrmance in PRCSIM.	0	1	2	3	4

4.4 Terminal Operation

4.41 Direct operation. The subjects who operated the terminals themselves were free to use any computer terminal on the campus. Most chose to use ones in the computer terminal room of McConnell Hall. These subjects were also able to use the terminal at any hour that the computer was available, generally from 8:00 AM to 11:00 PM. Instruction sheets on terminal operation for entering and printing the data, were given to these subjects. During most of the hours of play a terminal room supervisor was available to answer questions on general machine operation, but not on the specific game.

4.42 Indirect operation. Three different operators ran the terminals for the subjects using terminal operators. The three were students from other colleges in the University, who had not played this game, and were skilled terminal operators. The three were instructed in the game operation but were told not to discuss any decisions, strategy or results with the subjects. A schedule of about 20 hours per week was maintained with the operator at the terminal. The three operators varied the scheduled hours they took. Only one operator at a time was on duty.

Less waiting tcok place with the terminal operators than without them. But cccasional queues built up even with the terminal operators.

For the last six pericds cf the game, the subjects who had been required to use a terminal operator were given a choice. They could continue to use the operators or operate the terminals themselves. By the end of the game, about 40% of this group ran the terminals themselves for at least one period.

C H A P T E R V

RESULTS AND ANALYSIS

The first two chapters set the stage fcr this research. The intent and design for the study was stated in Chapter Three which included:

1. the proposed research model,
2. the independent and dependent variables, and
3. the research propositions.

The design of the experiment and data collection for this study was described in Chapter Four.

This chapter presents the results and analyses of the data that was collected. The data are shown in raw form and aggregated by the experimental groups. Then the data are used to test and analyze the research propositions by the classes of dependent variables:

1. profit effectiveness,
2. attitude toward the MIS, and
3. confidence from the learning envircnment.

Chapter Five concludes by discussing cbservations and qualitative feedback cbtained during the experiment.

5.1 Data Collected and Descriptive Statistics

Four types of information was collected on every subject: identification, cost effectiveness, questionnaire, and attribute data for use as covariates. These types of information were described in Chapters Three and Four. The identification and dependent variable data were grouped together to form a single record per subject.

5.11 Missing data. When studies use people as subjects, it is difficult tc insure that all desired data is collected. Such was the case with this study. Because the experiment was conducted over a two mcnth period, there was some attrition. Initially 84 subjects were selected and assigned to the experimental groups. Six subjects dropped out because they dropped the ccurse. They dropped after their midterm exam and prior to the end of the University's drop period without receiving a grade. In addition, 3 of the 78 failed to complete the dependent questionnaire administered after the experiment ended.

5.12 Experimental group data. In conducting behavioral research we are ccncerned with the effects experimental treatments have on the individual subjects. However to conduct higher level analyses it is desirable to group the individual data. By aggregating the data for all members of each group, by each dependent measure, we can produce

aggregated data which is descriptive of each group as a whole.

Such aggregation was done in this research to produce group characteristics which were used to test the research propositions. This aggregaticn was done for each of the eight dependent questicnnaire measures and for the cumulative cost efficiency scores fcr each period in the experimental game. The results of this aggregation are shown in Table 5.1, [51] and Appendix A, [52] .

The first five questionnaire measures were then combined to form an attitude variable for each group. The last three questions were combined tc produce a confidence variable. The combined attitude and confidence variables by group are shown in Table 5.2.

TABLE 5.1

MEANS AND STANDARD DEVIATICNS OF
INDIVIDUAL DEPENDENT MEASURES

Factor F	Factor T		Variable USEMIS	LEARNMIS	USEFACIL	YOUOPER	PERFCHNG
1	1						
		M	3.134	3.296	3.257	2.420	3.296
		SD	0.295	0.593	0.479	1.110	0.418
1	2						
		M	3.571	3.357	3.500	2.500	3.214
		SD	0.514	0.842	0.650	1.225	0.426
2	1						
		M	3.000	3.308	3.308	3.077	3.000
		SD	0.408	0.480	0.855	0.760	0.913
2	2						
		M	3.312	3.388	3.459	2.838	3.377
		SD	0.606	0.625	0.634	0.662	0.487
3	1						
		M	3.583	3.583	3.167	2.667	3.333
		SD	0.515	0.669	1.115	1.073	0.492
3	2						
		M	3.667	3.667	3.583	2.917	3.500
		SD	0.492	0.492	0.515	0.996	0.522

Factor F	Factor T		Variable DECQUAL	INFOASST	FACLASST	CEF21
1	1					
		M	84.082	81.928	82.369	830.308
		SD	6.378	8.965	10.113	158.409
1	2					
		M	82.857	86.429	82.143	929.714
		SD	11.387	8.419	13.688	59.678
2	1					
		M	82.692	83.077	83.077	920.846
		SD	9.268	7.511	16.013	58.202
2	2					
		M	75.824	78.038	76.100	936.429
		SD	11.629	14.683	12.128	39.187
3	1					
		M	81.667	84.167	74.583	967.583
		SD	9.129	12.583	26.582	33.454
3	2					
		M	82.500	81.667	84.167	957.833
		SD	9.653	13.371	13.114	43.016

F - Facilitator
1 - Systems Oriented
2 - User Oriented
3 - Team

T - Use of a Terminal Operator
1 - Yes
2 - No

TABLE 5.2

MEANS AND STANDARD DEVIATIONS OF
COMBINED DEPENDENT MEASURES

Factor F	Factor T		Variable ATTITUDE	Variable CONFID	Variable CEF21
1	1				
		M	3.135	82.793	830.308
		SD	0.273	6.890	158.409
1	2				
		M	3.229	83.810	929.714
		SD	0.443	8.044	59.678
2	1				
		M	3.138	82.949	920.846
		SD	0.386	7.270	58.202
2	2				
		M	3.275	76.654	936.429
		SD	0.309	10.142	39.187
3	1				
		M	3.267	80.139	967.583
		SD	0.334	9.279	33.454
3	2				
		M	3.467	82.778	957.833
		SD	0.403	10.902	43.016

F = Facilitator
1 - Systems Oriented
2 - User Oriented
3 - Team

T = Use of a Terminal Operator
1 - Yes
2 - No

5.13 Indicative group means. Tables 5.1, 5.2 and Appendix A provide us with a picture of the experimental groups. In examining the group means, certain characteristics seem to stand out.

1. The groups that had the facilitating team, 3-1 and 3-2, had higher cost efficiencies, variable CEF 21, than the groups having either individual facilitator.

2. The group that had a systems oriented facilitator and who used a terminal operator, 1-1, had decidedly lower cost efficiencies than any other group. Not only was the group mean lower, but the maximum and minimum individual subject efficiencies were considerably lower than the corresponding efficiencies for any other group.

3. Using a facilitating team and having the subjects operate the terminal themselves, group 3-2, produced the most favorable mean group attitudes on four of the five questions and the second most favorable attitude on the fifth question. This can also be seen in the combined attitude variable in Table 5.2.

4. Attitudes were more favorable for subjects who operated the terminals themselves when compared pairwise by group on terminal operation, i.e. group 1-1 with 1-2, or pair comparison within column, see Figure 3.2.

5. Confidence turned out to be lowest when the subjects had a user oriented facilitator and operated the terminals themselves, group 2-2.

5.14 Change in cost efficiency by period. Figure 5.1 shows the group cumulative cost efficiencies as they changed by period. Again certain features are distinctive.

1. The groups that had the facilitating team had the highest efficiencies through most decision periods.

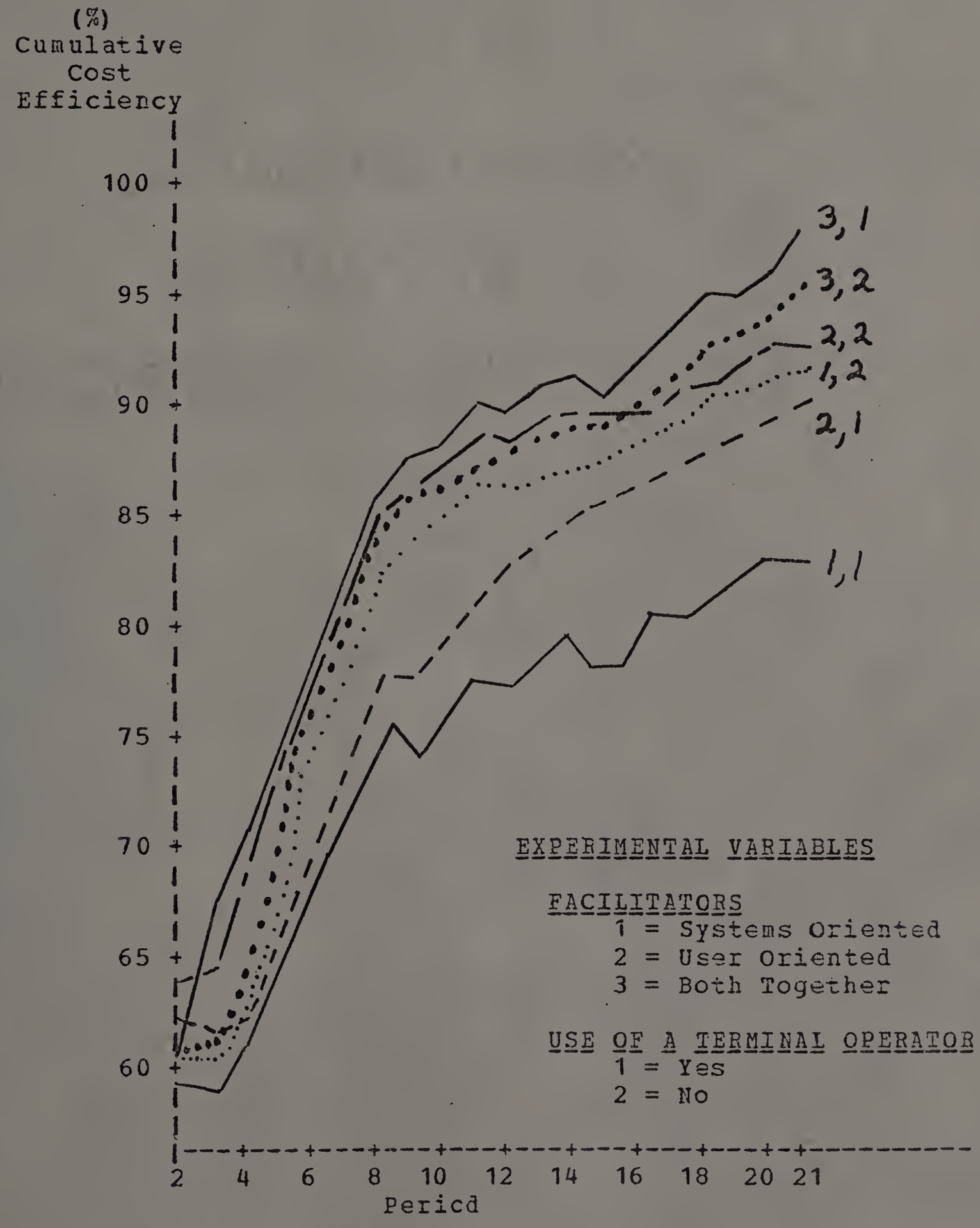
2. The group that had the facilitating team and who operated the terminal themselves had the highest efficiencies in every period after the first one.

3. The group that had a system oriented facilitator and used a terminal operatcr had decidedly lower efficiencies than any cther group through all periods.

4. The relative grcup ratings by the fourth decision period were similar tc those after the final period; and these relative ratings had little change between the fcurth and final periods.

FIGURE 5.1

GROUP MEAN CUMULATIVE COST EFFICIENCY (%) BY PERIOD



5.2 Single Criterion Analysis of Variance

Each of the classes of dependent measures were analysed separately by analysis of variance, ANOVA. [53] Section 5.3 presents the multiple analysis of variance, MANOVA, of the dependent variables. The researcher considered all of the factors to be fixed and therefore used a fixed effects model.

5.21 Foundations for use of ANOVA. [54] Analysis of variance was used to test whether the groups were significantly different from each other after the experiment, and to estimate the proportion of the variance that can be explained. The desire was to see how the variance in the dependent measures presumably due to the experimental treatment compared with the variance due to error or randomness. Variation between the groups was assumed due to the treatments. The variance within the groups measure all other causes of variation.

This study proposed that independent variables affect the subjects attitudes, confidence and behavior. Therefore the research was set up as a factorial design and a factorial analysis of variance was used. The factorial approach enabled manipulation and control of the variables simultaneously. The factorial approach also permitted hypotheses and tests of interactive effects between the

independent variables. The improved control from this approach reduced the within group or unexplained variance and therefore assisted in finding significance.

To further reduce the unexplained variance some of the subjects attributes were included as covariates in the analyses. The analyses were run with and without the covariates to see if they had any effect.

A regression approach was used in the analysis of variance because there was no intrinsic ordering to the relationship between the independent variables. That is the type facilitator should have no effect on the choice of using a terminal operator or vice versa.

5.22 ANOVA of cost efficiency without covariates. Table 5.3 presents the factorial analysis of variance of cost effiencies without including the covariates. Several results of the analysis are noteworthy.

1. The main effects produced a significant F ratio at the .001 alpha level. Grouping by facilitator orientation resulted in an F ratio that was significant at .001; and by terminal operation at the .052 level. These results suggest that both the type of facilitator and the use of a terminal operator affected the cost effiencies in this experiment.

2. Interaction between the independent variables gave an F ratio that was significant at the .036 level. Thus it seems that certain combinations of facilitators and use of terminal operators produce better cost efficiencies than other combinations.

This effect is demonstrated in the plot

in Figure 5.2. Because the lines have different slopes there is interaction. We can say that the differential effect between using a terminal operator or not depends on the type of facilitator.

Figure 5.2 also shows us that cost efficiencies are highest with a facilitating team, in the middle for a user oriented facilitator, and lowest for a system oriented facilitator; independent of the use of a terminal operator.

3. Table 5.3 also reveals that the independent factors and their interaction accounted for most of the variation. The F ratio for the explained variance was significant at the .001 level.

TABLE 5.3

ANOVA OF CUMULATIVE COST EFFICIENCY

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

CEF21 CUM.COST EFFICIENCY:ACT<STD EFF>1000
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

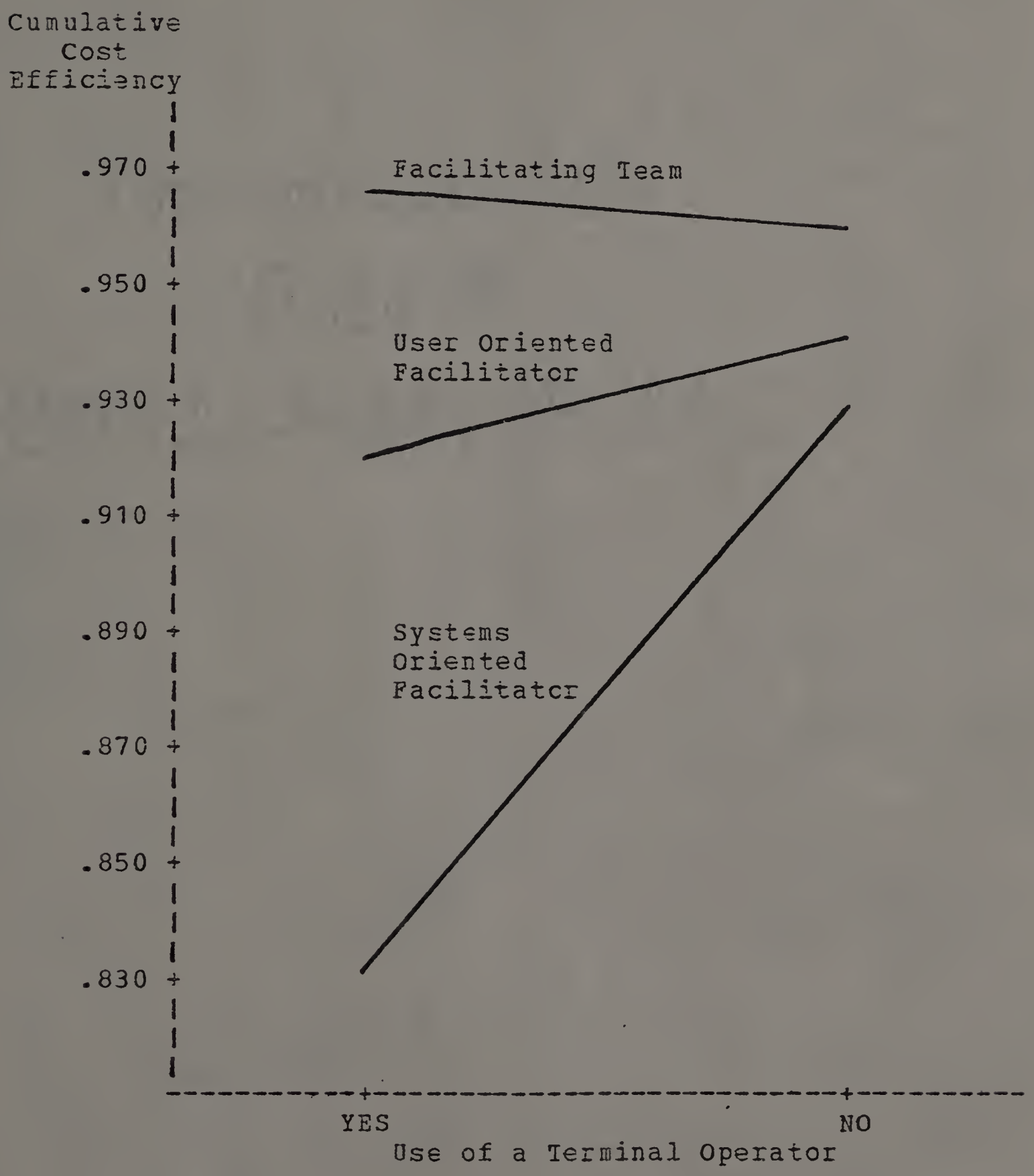
* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	111203.333	3	37067.778	6.056	0.001
FACLTATR	88490.387	2	44245.193	7.229	0.001
TERMOPER	23901.526	1	23901.526	3.905	0.052
2-way interactions	42456.906	2	21228.453	3.468	0.036
FACLTATR TERMOPER	42456.906	2	21228.453	3.468	0.036
Explained	153322.617	5	30664.523	5.010	0.001
Residual	440699.344	72	6120.824		
Total	594021.961	77	7714.571		

78 cases were processed.
0 cases (0.0 %) were missing.

FIGURE 5.2

FACILITATOR ORIENTATION and TERMINAL OPERATION
COST EFFICIENCY INTERACTION EFFECTS



5.23 Multiple comparison of facilitator levels. Figure 5.3 presents a posteriori contrasts for comparing type of facilitators using the Scheffe method of multiple comparisons. [55] The results of the procedure give us two homogeneous subsets of types of facilitators; which are:

1. Systems and user oriented facilitators

2. User oriented and facilitating team.

This can be shown using the group means of cost efficiency.

FIGURE 5.3

FACILITATOR GROUPING USING SCHEFFE METHOD

OF A POSTERIORI CONTRASTS

Facilitator Orientation

System	User	Team
881.85	928.93	962.71

5.24 ANOVA of combined attitude measure. Table 5.4 presents the factorial analysis of variance of the combined attitude measure without including covariates. The results indicate that:

1. The main effects produced a significant F ratio at the .091 level. Grouping by terminal operation gave an F ratio that was significant at the .086 level.

2. Interaction did not seem to have any significant affect on attitude.

3. Most of the variance in attitudes are not explained by the independent factors.

Even though the results are not strongly significant, Figure 5.4 demonstrates clear directions of the data. These are:

1. The use of a facilitating team produced the most favorable attitudes.

2. Direct terminal operation resulted in more favorable attitudes than use of a terminal operator.

3. There is little interaction between the type of facilitator and the use of a terminal operator on attitudes. This is shown by the parallel nature of the lines.

TABLE 5.4

ANOVA OF COMBINED ATTITUDE MEASURE

* * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * *

ATTITUDE
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

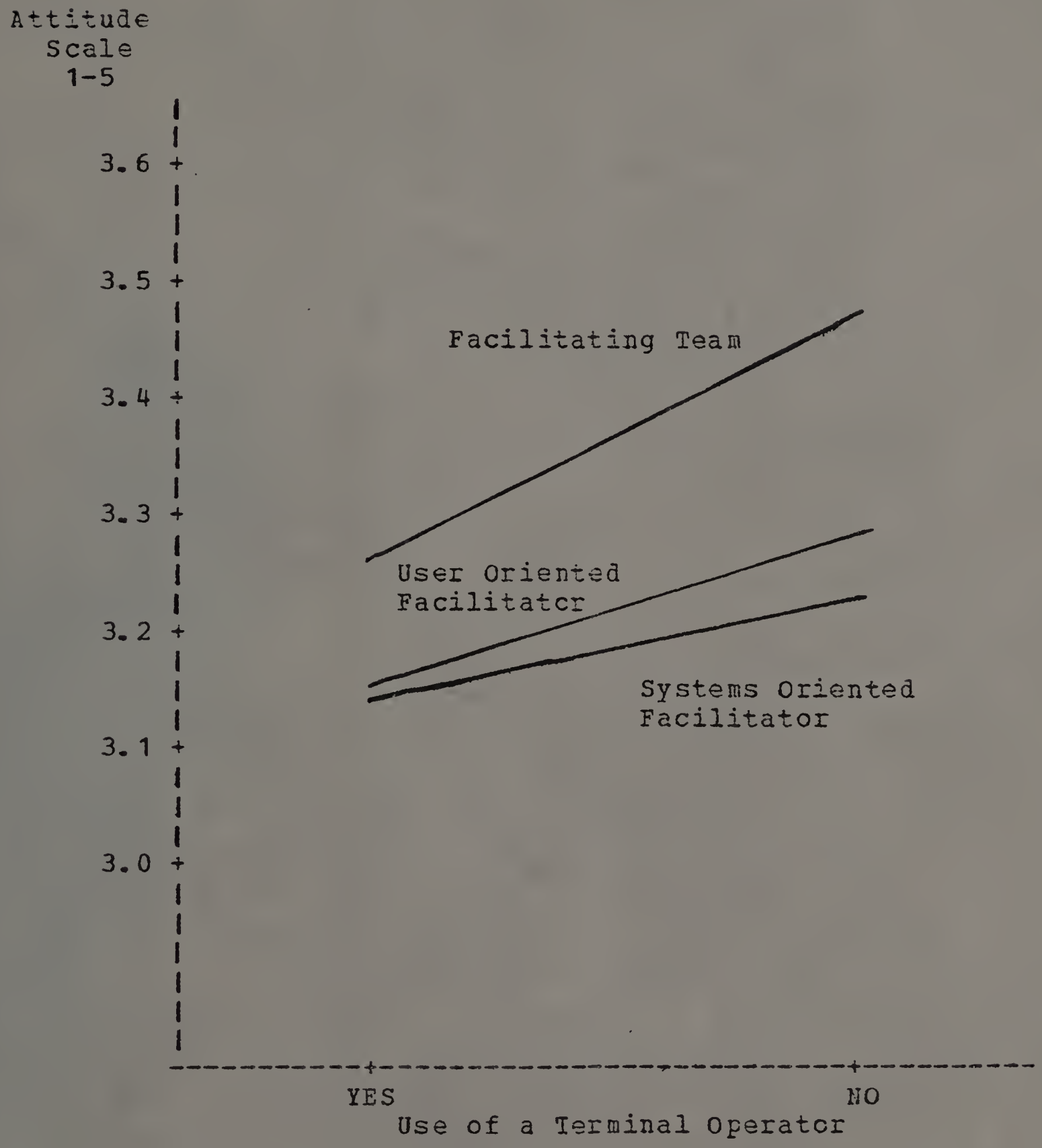
* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	0.887	3	0.296	2.243	0.091
FACLTATR	0.502	2	0.251	1.905	0.156
TERMOPER	0.399	1	0.399	3.028	0.086
2-way interactions	0.036	2	0.018	0.137	0.872
FACLTATR TERMOPER	0.036	2	0.018	0.137	0.872
Explained	0.915	5	0.183	1.389	0.239
Residual	9.492	72	0.132		
Total	10.408	77	0.135		

78 cases were processed.
0 cases (0.0 %) were missing.

FIGURE 5.4

FACILITATOR ORIENTATION and TERMINAL OPERATION
COMBINED ATTITUDE INTERACTICN EFFECTS



5.25 Analysis of individual attitude measures. Inclination to use an MIS in the future produced an F ratio that was significant at the .004 level for the type of facilitator; and at the .014 level for the type of terminal operation. None of the other individual attitude measures were particularly significant. The analysis of variance of the individual attitude measures are shown in Table 5.5.

Graphs of the five individual attitude questions are presented in Figure 5.5. While not as dramatic as the combined graph, certain features stand out.

1. The use of a facilitating team produced the most favorable attitudes on the three MIS questions relating to the use, learning about and change in job performance.
2. There was interaction between the independent factors on the individual questions.

TABLE 5.5

ANOVA OF INDIVIDUAL ATTITUDE MEASURES

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

USEMIS INCLINATION TO USE AN MIS FOR JOB ASSIST
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	4.238	3	1.413	6.044	0.001
FACLTATR	2.801	2	1.401	5.992	0.004
TERMOPER	1.497	1	1.497	6.404	0.014
2-way interactions	0.405	2	0.203	0.866	0.425
FACLTATR TERMOPER	0.405	2	0.203	0.866	0.425
Explained	4.718	5	0.944	4.037	0.003
Residual	16.829	72	0.234		
Total	21.547	77	0.280		

78 cases were processed.
0 cases (0.0 %) were missing.

TABLE 5.5 - CONTINUED

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

LEARNMIS INCLINATION TO LEARN MORE ABOUT AN MIS
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	1.477	3	0.492	1.228	0.306
FACLTATR	1.381	2	0.691	1.722	0.186
TERMOPER	0.108	1	0.108	0.270	0.605
2-way interactions	0.002	2	0.001	0.002	0.998
FACLTATR TERMOPER	0.002	2	0.001	0.002	0.998
Explained	1.479	5	0.296	0.738	0.598
Residual	28.868	72	0.401		
Total	30.347	77	0.394		

78 cases were processed.
0 cases (0.0 %) were missing.

TABLE 5.5 - CONTINUED

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

USEFACIL INCLIN.FOR FACIL. ASSIST LEARN USE MIS
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	0.958	3	0.319	0.592	0.622
FACLTATR	0.318	2	0.159	0.295	0.745
TERMOPER	0.631	1	0.631	1.170	0.283
2-way interactions	0.630	2	0.315	0.584	0.560
FACLTATR TERMOPER	0.630	2	0.315	0.584	0.560
Explained	1.511	5	0.302	0.560	0.730
Residual	38.835	72	0.539		
Total	40.347	77	0.524		

78 cases were processed.
0 cases (0.0 %) were missing.

TABLE 5.5 - CONTINUED

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

YOUOPER INCLIN.OPER.COMPUTER TERMINAL YOURSELF
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	3.464	3	1.155	1.179	0.324
FACLTATR	3.447	2	1.724	1.761	0.179
TERMOPER	0.018	1	0.018	0.018	0.893
2-way interactions	0.793	2	0.396	0.405	0.669
FACLTATR TERMOPER	0.793	2	0.396	0.405	0.669
Explained	4.180	5	0.836	0.854	0.516
Residual	70.487	72	0.979		
Total	74.667	77	0.970		

78 cases were processed.
0 cases (0.0 %) were missing.

TABLE 5.5 - CONTINUED

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

PERFCHNG IF USE MIS-EXPECTED CHANGE IN JOB PERF
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	1.132	3	0.377	1.171	0.327
FACLTATR	0.689	2	0.345	1.069	0.349
TERMOPER	0.461	1	0.461	1.429	0.236
2-way interactions	0.713	2	0.356	1.106	0.336
FACLTATR TERMOPER	0.713	2	0.356	1.106	0.336
Explained	1.830	5	0.366	1.135	0.350
Residual	23.211	72	0.322		
Total	25.041	77	0.325		

78 cases were processed.
0 cases (0.0 %) were missing.

FIGURE 5.5

FACILITATOR ORIENTATION and TERMINAL OPERATION
INDIVIDUAL ATTITUDE INTERACTION EFFECTS

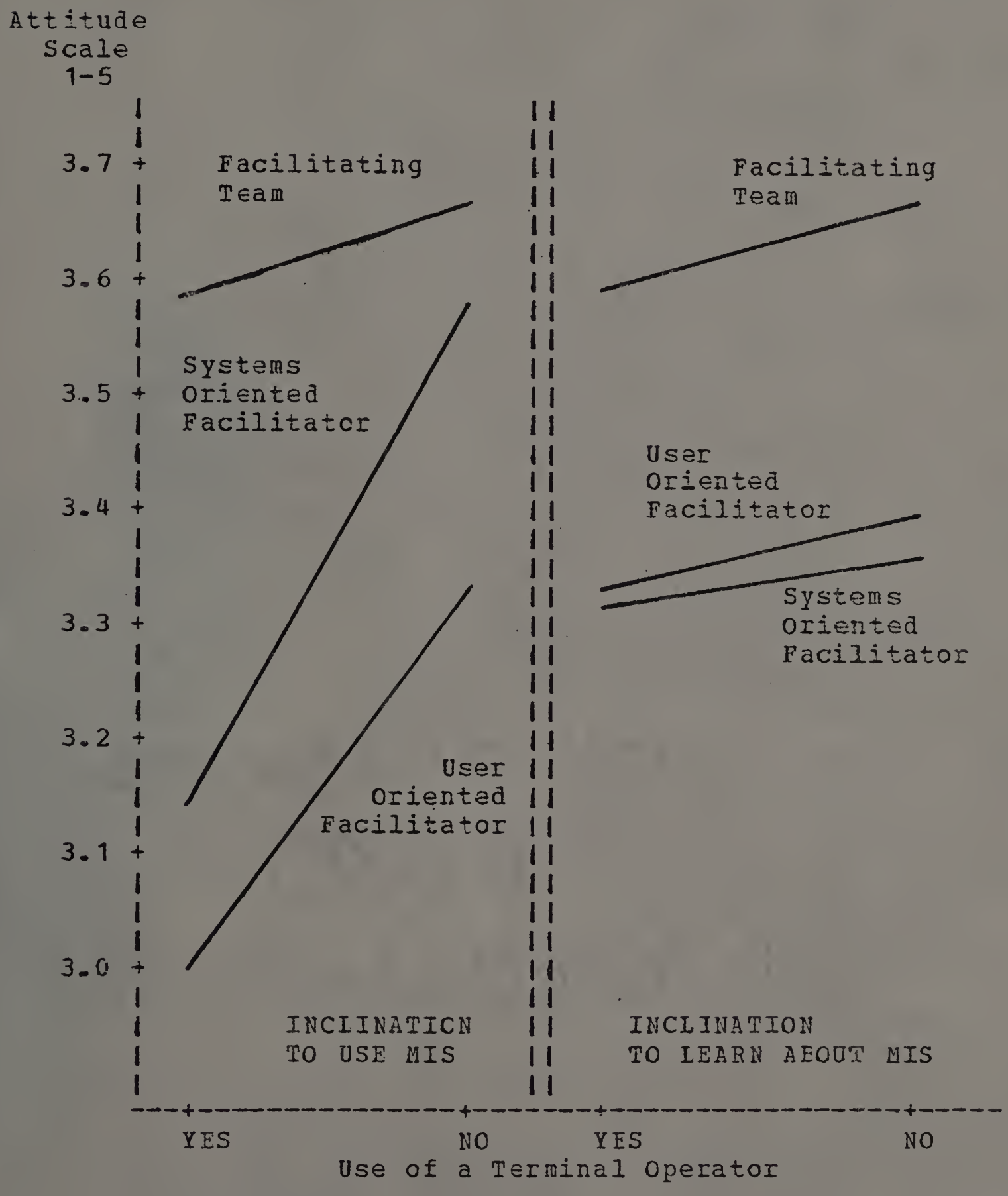


FIGURE 5.5 - continued

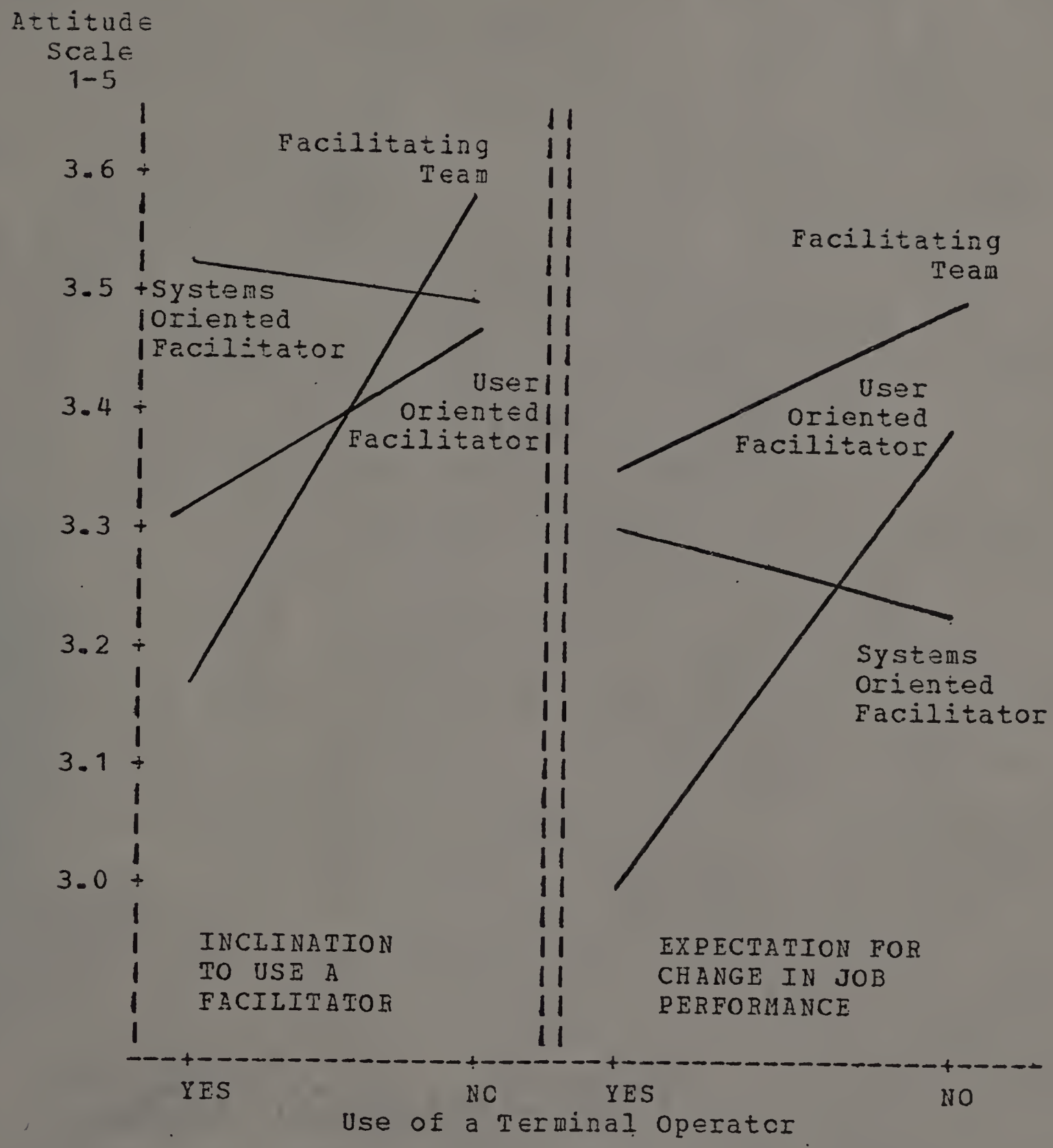
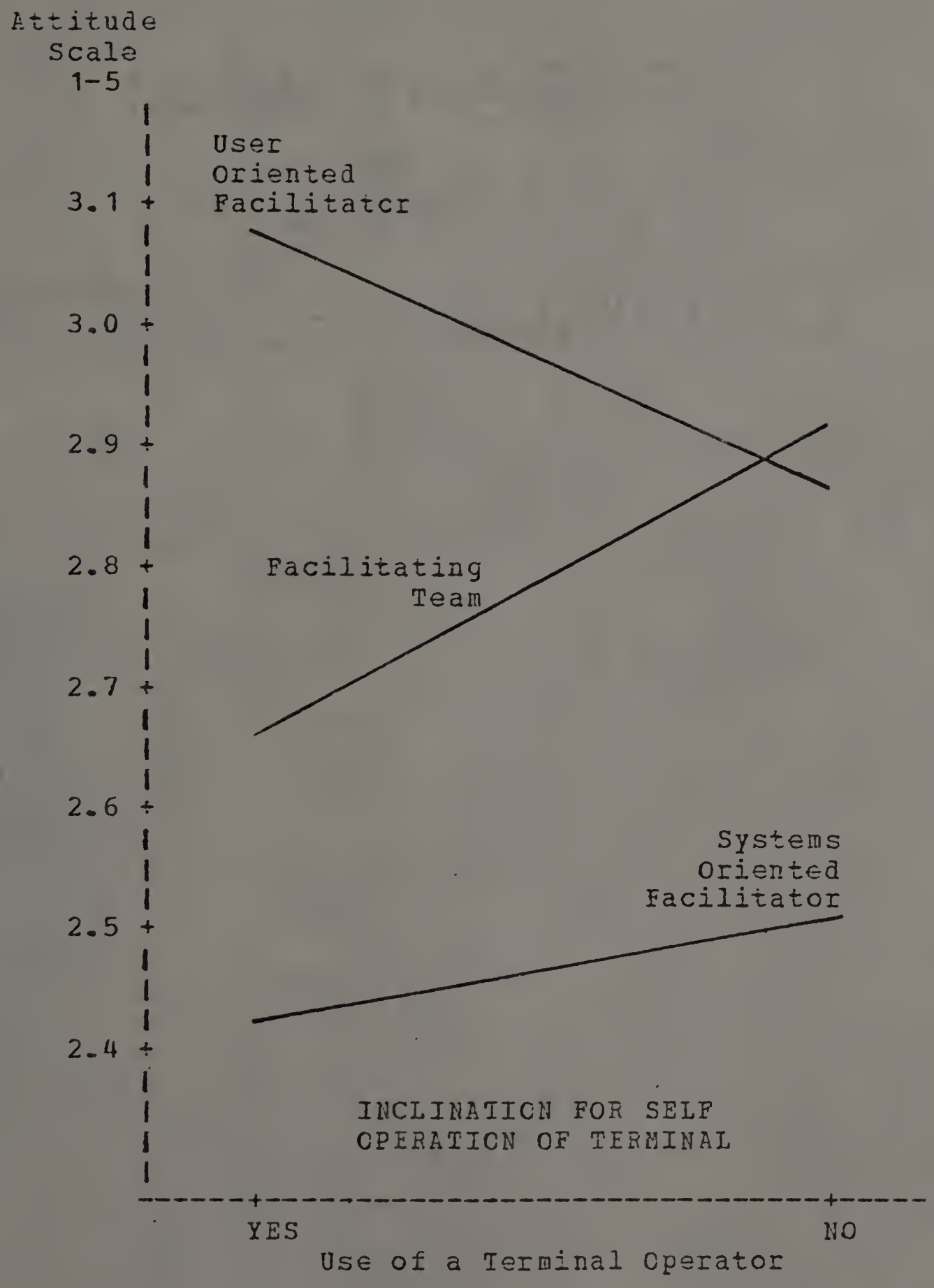


FIGURE 5.5 - continued



5.26 ANOVA of confidence measure. Table 5.6 presents the factorial analysis of variance of the combined confidence measure without including covariates. The results do not produce F ratios which are statistically significant.

Interactions between the type of facilitator and use of a terminal operator is shown in Figure 5.6. Because the interactions are non symmetric and disordinal they are hard to interpret.

Table 5.7 contains the analysis of variance of the individual confidence measures. They did not produce F ratios which are statistically significant.

5.27 Analyses using covariates. The use of the covariates in the analyses did not materially help add to the significance or reduce the unexplained variance. The factorial analyses of variance of the combined dependent measures including the covariates are shown in Appendix C.

TABLE 5.6

ANOVA OF COMBINED CONFIDENCE MEASURE

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

CONFID
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	180.282	3	60.094	0.768	0.516
FACLTATR	165.291	2	82.645	1.056	0.353
TERMOPER	15.035	1	15.035	0.192	0.663
2-way interactions	295.826	2	147.913	1.889	0.159
FACLTATR TERMOPER	295.826	2	147.913	1.889	0.159
Explained	494.290	5	98.858	1.263	0.289
Residual	5636.673	72	78.287		
Total	6130.963	77	79.623		

78 cases were processed.
0 cases (0.0 %) were missing.

TABLE 5.7

ANOVA OF INDIVIDUAL CONFIDENCE MEASURES

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

DECQUAL CONFIDENCE [%] IN QUALITY OF YOUR DECISI
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	362.531	3	120.844	1.260	0.295
FACLTATR	247.719	2	123.859	1.292	0.281
TERMOPER	113.750	1	113.750	1.186	0.280
2-way interactions	206.230	2	103.115	1.075	0.347
FACLTATR TERMOPER	206.230	2	103.115	1.075	0.347
Explained	594.252	5	118.850	1.239	0.300
Residual	6904.415	72	95.895		
Total	7498.667	77	97.385		

78 cases were processed.
0 cases (0.0 %) were missing.

TABLE 5.7 - CONTINUED

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

INFOASST CONFIDENCE [%] MIS INFO.ASST.DEC.MAKING
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	202.011	3	67.337	0.534	0.660
FACLTATR	181.752	2	90.876	0.721	0.490
TERMOPER	19.924	1	19.924	0.158	0.692
2-way interactions	327.358	2	163.679	1.299	0.279
FACLTATR TERMOPER	327.358	2	163.679	1.299	0.279
Explained	544.953	5	108.991	0.865	0.509
Residual	9073.714	72	126.024		
Total	9618.666	77	124.918		

78 cases were processed.
0 cases (0.0 %) were missing.

TABLE 5.7 - CONTINUED

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

FACLASST CONFIDENCE [%] IN FACILITATOR'S ASSIST
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

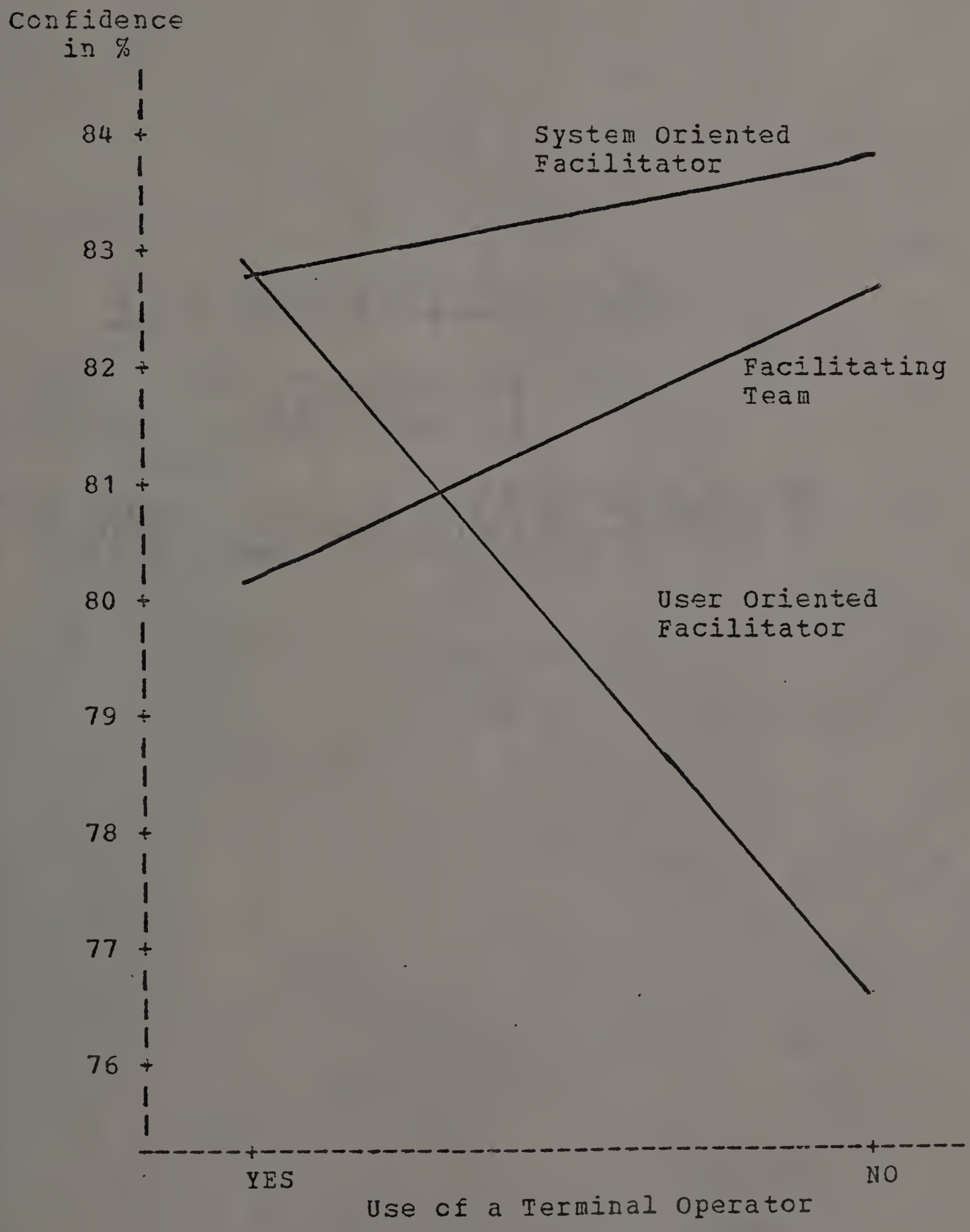
* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	148.659	3	49.553	0.195	0.900
FACLTATR	135.694	2	67.847	0.267	0.767
TERMOPER	12.225	1	12.225	0.048	0.827
2-way interactions	875.403	2	437.701	1.721	0.186
FACLTATR TERMOPER	875.403	2	437.701	1.721	0.186
Explained	1021.212	5	204.242	0.803	0.551
Residual	18316.789	72	254.400		
Total	19338.000	77	251.143		

78 cases were processed.
0 cases (0.0 %) were missing.

FIGURE 5.6

FACILITATOR ORIENTATION and TERMINAL OPERATION
CONFIDENCE INTERACTION EFFECTS



5.3 Multiple Criteria Analysis of Variance

This research proposed multiple criteria for evaluating the effects of the independent variables. Because the independent variables were nominally scaled and the criterion variables had equal appearing intervals, multiple analysis of variance was used to analyse the association. (Green and Tull, 1975, and Andrews, et al, 1975)

5.31 MANOVA of combined measures without covariates. Table 5.8 shows that there is relatively low intercorrelations between the combined dependent measures. This permits examining the dependent measures separately as well as jointly.

Tables 5.9, 5.10 and 5.11 present the multiple analysis of variance on the facilitator, test of F; terminal operator, test of T; and interaction, test of FT. The multivariate tests yielded roots with the following significance:

1. The first root for the type of facilitator had an F ratio which is significant at the .015 level.

2. The type of terminal operator had an F ratio which is significant at the .097 level.

3. The F ratio for the first root of the interaction is significant at the .058 level.

5.32 MANOVA of individual measures without covariates.

TABLE 5.8

WITHIN CELLS CORRELATIONS OF CRITERIA WITH STANDARD DEVIATIONS ON DIAGONAL

VARIABLE	ATTITUDE	CONFID	CEF21
ATTITUDE	0.363		
CONFID	0.341	8.848	
CEF21	0.226	-0.063	78.236

ESTIMATES ADJUSTED FOR 0 COVARIATES

CONTRAST		CRITERIA ATTITUDE	CONFID	CEF21
F				
	1	-0.070	1.781	-43.775
	2	-0.045	-1.719	4.852
T				
	1	-0.072	0.440	-17.540
FT				
	1	0.025	-0.948	-32.163
	2	0.003	2.707	9.749

TABLE 5.9

MANOVA TEST OF FACILITATOR OF COMBINED MEASURES

TEST OF F

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	2.734	6.000	140.000	0.015	0.423
2 THROUGH 2	0.857	2.000	70.500	0.429	0.154

UNIVARIATE F TESTS

VARIABLE	F(2, 72)	MEAN SQ	P LESS THAN	STANDARDIZED DISCRIMINANT COEFFICIENTS
ATTITUDE	1.861	0.245	0.163	0.334
CONFID	1.140	89.222	0.326	-0.294
CEF21	6.903	42252.875	0.002	0.843

DISCRIMINANT SCORES

CONTRAST	1
1	-0.595
2	0.068

TABLE 5.10

MANOVA TEST OF TERMINAL OPERATION OF COMBINED MEASURES

TEST OF T

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 1	2.193	3.000	70.000	0.097	0.293

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(1, 72)	MEAN SQ	P LESS THAN	COEFFICIENTS
ATTITUDE	2.946	0.388	0.090	0.646
CONFID	0.256	20.015	0.615	-0.375
CEF21	4.307	26359.988	0.042	0.628

DISCRIMINANT SCORES

CONTRAST	1
1	-0.287

TABLE 5.11

MANOVA TEST OF INTERACTION OF COMBINED MEASURES

TEST OF FT

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	2.093	6.000	140.000	0.058	0.342
2 THROUGH 2	1.697	2.000	70.500	0.191	0.214

UNIVARIATE F TESTS

VARIABLE	F(2, 72)	MEAN SQ	P LESS THAN	STANDARDIZED DISCRIMINANT COEFFICIENTS
ATTITUDE	0.137	0.018	0.872	-0.523
CONFID	1.889	147.913	0.159	0.516
CEF21	3.468	21228.451	0.036	0.967

DISCRIMINANT SCORES

CONTRAST	1
1	-0.489
2	0.274

Table 5.12 shows that most of the independent measures have relatively low intercorrelation. As with the combined measures, this permits both separate and joint analyses of the individual dependent measures.

Tables 5.13, 5.14 and 5.15 contain the multiple analysis of variance on the facilitator, test of F; terminal operator, test of T; and interaction, test of FT. The multivariate tests yielded roots with the following significance:

1. The first root for the type of facilitator had an F ratio which is significant at the .095 level.

2. The type of terminal operator had an F ratio which is significant at the .033 level.

3. The F ratio for the first root of the interaction is significant at the .292 level.

5.33 MANOVA with covariates. The use of the covariates in the analyses did not materially help add to the significance or reduce the unexplained variance. The multiple analyses of variance of the dependent measures including the covariates are shown in Appendix D.

TABLE 5.12

WITHIN CELLS CORRELATIONS OF CRITERIA WITH STANDARD DEVIATIONS ON DIAGONAL ADJUSTED FOR 0 COVARIATES

VARIABLE	USEMIS	LEARNMIS	USEFACIL	YOUOPER	PERFCHNG	DECQUAL	INFOASST	FACLASST	CEF21
USEMIS	0.483								
LEARNMIS	0.408	0.633							
USEFACIL	-0.011	0.223	0.734						
YOUOPER	0.070	0.199	-0.093	0.989					
PERFCHNG	0.106	0.118	0.141	-0.062	0.568				
DECQUAL	0.288	0.139	0.172	0.088	0.361	9.793			
INFOASST	0.343	0.038	-0.075	-0.077	0.112	0.435	11.226		
FACLASST	0.046	0.095	0.479	-0.068	0.317	0.379	0.039	15.950	
CEF21	0.082	0.329	-0.124	0.198	0.100	0.008	-0.047	-0.078	78.236

ESTIMATES ADJUSTED FOR 0 COVARIATES

CONTRAST		CRITERIA						
F		USEMIS	LEARNMIS	USEFACIL	YOUOPER	PERFCHNG	DECQUAL	INFOASST
	1	-0.025	-0.106	0.090	-0.276	-0.032	1.866	1.628
	2	-0.222	-0.085	-0.041	0.221	-0.098	-2.346	-1.993
T								
	1	-0.139	-0.037	-0.090	-0.015	-0.077	1.210	0.506
FT								
	1	-0.080	0.007	0.104	-0.025	0.118	-0.598	-2.757
	2	-0.017	-0.003	0.014	0.135	-0.112	2.224	2.013

CONTRAST		CRITERIA	
F		FACLASST	CEF21
	1	1.850	-43.775
	2	-0.818	4.852
T			
	1	-0.397	-17.540
FT			
	1	0.510	-32.163
	2	3.885	9.749

TABLE 5.13

MANOVA TEST OF FACILITATOR OF INDIVIDUAL MEASURES

TEST OF F

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	1.514	18.000	128.000	0.095	0.461
2 THROUGH 2	1.277	8.000	64.500	0.271	0.370

UNIVARIATE F TESTS

VARIABLE	F(2, 72)	MEAN SQ	P LESS THAN	STANDARDIZED DISCRIMINANT COEFFICIENTS
USEMIS	5.841	1.365	0.004	0.648
LEARNMIS	1.708	0.685	0.188	-0.087
USEFACIL	0.287	0.155	0.751	0.024
YOUOPER	1.725	1.689	0.185	0.029
PERFCHNG	1.020	0.329	0.366	0.270
DECQUAL	1.366	130.984	0.262	-0.204
INFOASST	0.793	99.890	0.457	-0.145
FACLASST	0.279	70.851	0.758	-0.098
CEF21	6.903	42252.875	0.002	0.714

DISCRIMINANT SCORES

CONTRAST	1
1	-0.510
2	-0.203

TABLE 5.14

MANOVA TEST OF TERMINAL OPERATION OF INDIVIDUAL MEASURES

TEST OF T

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 1	2.209	9.000	64.000	0.033	0.487

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(1, 72)	MEAN SQ	P LESS THAN	COEFFICIENTS
USEMIS	6.770	1.582	0.011	0.870
LEARNMIS	0.268	0.108	0.606	-0.492
USEFACIL	1.060	0.572	0.307	0.471
YOUOPER	0.010	0.009	0.923	0.060
PERFCHNG	1.425	0.459	0.237	0.331
DECQUAL	1.315	126.055	0.255	-0.597
INFOASST	0.141	17.815	0.708	-0.070
FACLASST	0.016	4.107	0.899	-0.022
CEF21	4.307	26359.988	0.042	0.543

DISCRIMINANT SCORES

CONTRAST	1
1	-0.522

TABLE 5.15

MANOVA TEST OF INTERACTION OF INDIVIDUAL MEASURES

TEST OF FT

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	1.175	18.000	128.000	0.292	0.414
2 THROUGH 2	1.011	8.000	64.500	0.437	0.334

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(2, 72)	MEAN SQ	P LESS THAN	COEFFICIENTS
USEMIS	0.866	0.203	0.425	0.189
LEARNMIS	0.002	0.001	0.998	-0.335
USEFACIL	0.584	0.315	0.560	-0.057
YOUOPER	0.405	0.396	0.669	-0.036
PERFCHNG	1.106	0.356	0.336	-0.583
DECQUAL	1.075	103.115	0.347	0.079
INFOASST	1.299	163.679	0.279	0.415
FACLASST	1.721	437.701	0.186	0.272
CEF21	3.468	21228.451	0.036	0.838

5.4 Observations and Qualitative Feedback

Most of the subjects made gradual transitions from confusion at the start of the experiment, to understanding someplace along the way. There was confusion over how to integrate the irfcrmaticn system into their decision making to maximize their results. Some subjects were reluctant to start and move ahead due tc concern with procedures for using the ccmputer system. Because participation and continuation was mandatory, and because students are socialized to carry out assignments, all subjects who began the experimental game carried it out on schedule. There were large variations in the time devoted tc making the decisions. All subject attrition took place prior to the second decisicn period.

The user oriented facilitatcr was asked several questions during the initial training session and at each follow up session. This facilitatcr was sought out between sessions to answer questions and be informed of progress. There was a general subject feeling that the user oriented facilitator was interested in their learning and progress.

The systems criented facilitator was asked relatively few questions at any time and was rarely scught out. The questions that were put tc him, were generally well stated with clearly defined answers. The subjects feeling confused and lacking understanding rarely approached the systems

oriented facilitator.

Most subjects sought out information from wherever they could find answers or from the people they were most comfortable with, e.g. other subjects, terminal operators, friendly teachers, etc.

Many of the subjects who used the terminal operators, expressed desires to operate the terminals themselves about half way through the experiment. When this occurred, it was after the subject understood how to integrate the information system into his decision making. These subjects were given the option to operate the terminals themselves for the final six decision periods.

C H A P T E R V I

DISCUSSION

This study was undertaken to help shed additional light on how to get organizations to make more effective use of information systems to support their decision making. The earlier chapters showed that MIS are not effectively used, and that much is still unknown about the factors that lead to effective use.

Based upon a review of the ideas and findings of others a research model was proposed for the factors leading to successful implementation of MIS. From this model, the implementation or learning environment of the decision maker was singled out for examination. This research focused on the effects that different types of facilitators and terminal operation would have on decision maker's effectiveness, attitude and confidence during that learning period. A series of propositions were presented, that the types of these factors which promoted more decision maker involvement would produce more positive performance and behavioral responses.

This chapter examines these propositions in light of the results that were obtained. Then inferences are drawn that these key variables can be used to predict effectiveness in the implementation environment. Finally

generalizations are made to strategies that can be determined which increase the chances of developing successful information systems.

6.1 Facilitators and Terminal Operations

Table 6.1 presents a summary of the support for the research propositions that are provided by these results. One overriding generalization is evident, different types of facilitators and terminal operation will produce different levels of decision effectiveness and behavioral response in decision makers, when they are learning to use an MIS.

TABLE 6.1

SUMMARY OF SUPPORT BY PROPOSITION NUMBER

	Amount of Support		
Facilitators	Strong	Moderate	None
Effectiveness	1, 2	3, 4	
Attitude	5	6, 7	8
Confidence			9, 10
Terminal Operation			
Effectiveness	11	12	
Attitude	13	14	
Confidence			15
Interaction			
Effectiveness	x		
Attitude			x
Confidence			x

6.11 Facilitator's impact on decision effectiveness. The analysis of variance provided strong support for hypothesis 1. The decision performance was clearly best when a team of two facilitators was used, one who was oriented toward the user and the other oriented toward the system. The team approach produced the greatest effectiveness through the early decision periods as well as at the end of the learning period, thus supporting hypothesis 3.

In a similar way support is provided for propositions 2 and 4. The analyses showed that a facilitator who is oriented toward the user will produce better decision effectiveness than one who is oriented toward the system.

We can conclude that decision makers respond better when learning to use an MIS when more concern is given to the type of facilitator who will assist them. The facilitator can play an important role in overcoming the decision maker's resistance to change. It seems that using this type of facilitating team breaks down this resistance, gets the decision makers more involved and produces better performance. It also follows that if a single facilitator is used, the results are improved when he is oriented toward the decision maker rather than the system.

However, we cannot say whether the best result is due to:

1. Teaming facilitators, i.e. more variation in presentation and assistance,

2. Lower decision maker-facilitator ratios, i.e. student-teacher ratics,

3. Grouping which combines understanding and support with expertise, or

4. Better matching cf decision styles between the facilitator and decision makers.

6.12 Facilitator's impact on behavioral factors. The analysis of variance provided strong support for hypothesis 5. The decision maker's inclinatien to use a similar MIS for assistance in his job in the future was clearly highest when a team of two facilitatcrs were used. The same team impact seems to be evident on generating positive attitudes, hypothesis 7, even though significance is not very high.

The analysis seemed to support the alternative hypothesis tc number 6. That is a facilitator who is systems oriented will prcduce higher inclinations to use an MIS than one who is user oriented.

The mixed respcnses to the attitude questions between groups facilitated by systems cr user oriented people, indicate no support for hypcthesis 8. Similarly, no inferences can be drawn about facilitators' effect on decision makers' confidence, hypotheses 9 and 10.

We can conclude that after such a learning period, decision makers who were facilitated by a team are more inclined to use such an MIS in the future, and they seem to have more positive attitudes toward MIS. However, it is

difficult to suggest that a user or a systems oriented facilitator will produce better attitudes toward an MIS.

6.13 Terminal operation's impact on decision effectiveness. The analysis of variance provided strong support for hypothesis 11. The decision performance was clearly better when the decision maker operated the terminal himself than when he used a terminal operator. The same result seems to hold true through the early decision periods, as well as at the end of the learning period, thus supporting hypothesis 12.

However interactions have a pronounced effect. Therefore conclusions will be discussed after discussing the interactions in section 6.15.

6.14 Terminal operation's impact on behavioral factors. The analysis of variance provided strong support for hypothesis 13 and reasonable support for 14. The decision maker's inclination to use a similar MIS for assistance in his job in the future was clearly higher when he operated the terminal himself. The same is true for his combined attitude toward MIS.

However no support was provided for proposition 15, the impact of terminal operation on a decision maker's confidence.

Therefore we can conclude that, when decision makers operate terminals themselves during learning about MIS, they will be more inclined to make use of the MIS in the future and have more positive attitudes toward the MIS.

6.15 Facilitator and terminal operation interactive impacts. The analysis of variance provided strong support for interaction effects on decision effectiveness. Not only are the type of facilitator and terminal operation important influences, but certain combinations of those factors produce distinctively different impacts on decision effectiveness. Perhaps most dramatic is the decidedly lower performance of the subjects who had a systems oriented facilitator and a terminal operator. This combination may result in lack of involvement of the decision makers in the implementation and an inability to overcome their resistance to change.

The interaction seemed to produce one out of rank order effect of the six experimental groups on decision effectiveness. When the facilitating team was combined with direct terminal operation, performance was lower than might be expected throughout all decision periods, see Figure 5.1. This combination of factors ranked second highest at the end of the learning period, rather than highest as might be expected.

However, the use of a facilitating team and direct terminal operation generated the greatest inclination to use the MIS to assist in decision making in the future. That combination also yielded the most positive attitude.

6.2 A Behavioral Theory on the Implementation of MIS

The results of this experiment tend to support the model of the MIS implementation environment proposed in Chapter 3. We have been able to identify specific factors and conditions that influence decision makers performance and attitude while they are learning to use an MIS. We were not able to show that the type of facilitator and terminal operation during implementation influence a decision maker's confidence. Perhaps a longer trial period with more reinforcement is needed. Maybe the concern about giving up known methods when changing to new ones, impedes the development of confidence in the new methods.

The type of facilitator orientation and direct use of the computer terminals get at involving the decision managers in their introduction to the MIS during the implementation. Team facilitation and direct terminal operation should promote decision maker involvement and the desired behavioral change. This involvement should help make the decision makers responsible for their own learning, get them committed to learn how to use the MIS in support of their decision making, encourage their willingness to give the MIS a reasonable trial, overcome their resistance to change, and give them positive feedback on their performance using an MIS.

This research suggests that we are able tc make desired changes in a decision maker's recently acquired attributes, his experience and attitude. Decision makers will generally learn and use new supporting methods if they see improvements in their perfcrmance and develop favorable attitudes when they learn about the new methods. This makes the implementation period quite important to acceptance and future MIS use. It alsc prcvides a way to deal with the poorly understood managerial decision making environment.

This research and these factors add to our understanding of the MIS implementation environment. However they alone are nct sufficient to predict or control for the successful implementation of ccmputer-based information systems. Strategies to use this theory is discussed in the follcwing secticn. Chapter 7 deals with the limitaticns of this study and the need for additional research.

6.3 A Strategy for Implementing MIS

The results of this study indicate that much more concern must be given to how information systems are implemented. Managers and systems analysts responsible for introducing new MIS must get the potential users involved in learning to use the MIS. The implementation is a trial period. If the users resistance to change is not overcome during implementation, the chances are slim that they will later accept and use the MIS. This will perpetuate the general lack of success of most MIS, with the resulting problems of: withdrawal and underuse of the systems, costs exceeding benefits, and discouragement and turnover of talented and high paid systems personnel.

What is needed is a strategy for implementation that is as important as the technical capability of the information system. Implementation must be well planned and given adequate time. A team approach should be used to facilitate or guide learning. Part of the team should be oriented toward the user. One way to do this would be to take an interested capable decision maker, who is a potential user, include him in the system's development and testing, and then make him part of the facilitating team.

Introduction, learning and trial should take place in an educational like setting, not in the decision maker's regular office. The purposes are to get the decision maker

involved in learning to use the new MIS, nct to rely on their existing methcds but to try the new ones in support of their decision making, and tc lcck to the facilitators for assistance.

The learning period shculd include "hands cn" operation of the computer terminals, even if the decision makers aren't going to operate the terminals later, during regular system operation. How they get introduced tc the terminal operation and the degree cf assistance with terminal operation, should vary with the complexity of the system.

A strategy such as this should prcmote positive attitude and behavicral change during implementation. This positive behavioral response should then increase the likelihood that the decision makers will use the computer based infcrmatien systems in the future.

C H A P T E R V I I

LIMITATIONS AND DIRECTIONS FOR RESEARCH

The principal aim cf this research is to make a contribution toward understanding the factors that influence decision makers' effectiveness and attitude when they are learning about information systems tc support their decision making. The presumpticns are that more positive effectiveness and attitude will lead to mcre likely future use of the information systems, and that use of MIS are necessary for their success.

This chapter discusses scme of the limitations of this study and directions for additicnal research.

7.1 Limitations

This study had several limitations considering its implications for implementing information systems in organizations. The experiment examined a limited set of variables out of the large number that may influence use of MIS. Only the variables in the implementation environment were considered. The ones outside that environment, such as those in the complete research model, Figure 3.1, were systematically excluded. These variables may affect the presumptions that more positive effectiveness and attitude will lead to more likely future MIS use. It is generally difficult to specify the attitude-behavioral linkage.

Within the implementation environment, only the type of facilitator and terminal operation were considered. There are several variations on the number and orientation of facilitators that could have been included. While the facilitators were chosen and rehearsed carefully, then examined to insure that they modeled the desired behavior, they can't represent the broad range of styles and orientations that could be found in facilitators. It is also possible that the terminal operators' actions or communications may have caused unwanted or uncontrolled effects.

Because the subjects were students and the experiment part of a course, there would be some difference from decision makers learning to use the MIS for their ongoing jobs. However, decision makers learning to use an MIS would assume student like roles when taught in an education setting.

The experiment used a game which forced the participants to make decisions that they hadn't made before and which they might not feel that they would make in the future.

Some conditions and events may have affected the internal validity of the study, even though random subject assignment and controls were used. The sample size was reasonably small, so the attrition, thought limited, could have biased the results. There is the possibility that uncontrolled and undetected information was received by subjects or exchanged between them. It was assumed that the observations were drawn from a population normally distributed, that the measures are intervally scaled and that there was homogeneity of variance.

The attitude and confidence measuring instrument was constructed for this experiment and therefore untested. We can't be sure that the questions were interpreted the way they were meant. There is also the possibility of inaccuracies in the subjects answers due to the subjects

inability or unwillingness tc provide the desired information, and variations among subjects in scoring.

7.2 Directions for Research

This research was exploratory in nature. Since support was obtained for the research model, there are a number of interesting directions for future research on the proposed model. Some of these are:

1. Explore the implementation of a real MIS in an actual organization under experimental control. It may be hard to find a suitable organization with an adequate sample size where random assignment can take place.

2. Study a number of recent or current MIS implementations, characterizing them by type of facilitator and terminal operation during implementation. It may be difficult to obtain objective measures of decision effectiveness.

3. Conduct a similar study varying:
   a. the subject, i.e. use actual managers attending a seminar;
   b. the facilitators;
   c. and the decision environment or game.

4. Investigate more of the variables in the research model, in addition to the implementation environment, by extending the time period of the study.

If further research supports this author's research model, it will strengthen the model's ability to predict and explain MIS use in organizations.

FOOTNOTES

11. Computer Yearbook, 1972, from EIA Marketing Department Estimates.

12. Fortune, June 5, 1978, Vol. 97, No. 11, from International Data Corporation.

13. A study by Venture Development Corporation, Wellesly, Massachusetts, as reported in Computerworld, March 1, 1976, page 33.

14. A study by International Data Corporation, Waltham, Massachusetts, as reported in Computerworld, March 1, 1976, page 33.

21. Gorry and Morton define DSS as information systems which support partially or wholly unstructured decision making. (See Section 2.32)

22. Slotkin supports his contention from his experience as vice-president and general manager of corporate services at Systems Development Corp.

51. This report was produced by a computer program from a group of programs for multivariate analysis of variance (MANOVA), supplied by Old Dominion University.

52. The subprogram AGGREGATE was used from the computer programs in the Statistical Package for the Social Sciences (SPSS) to produce this report. (Nie, et al, 1975)

53. Computer programs from the Statistical Package for the Social Sciences were used for the analysis of variance.

54. Theory and support for the analysis were obtained from Green and Tull, 1975, Kerlinger, 1973, Lindman, 1974, and Neter and Wasserman, 1974.

55. The Scheffe method was used because it is the most conservative of the available tests and it is exact even for unequal group sizes. (Nie, et al, 1975)

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APPENDIX A

AGGREGATION BY EXPERIMENTAL GROUP VARIABLES
File EXPDAT (Creation date = 21-Feb-78) FROM PROSIM ON MIS LEARNING

A G G R E G A T E

Group Variables:
FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

Group-ID 1 Total N 13 Group-values 1. 1.

Variable	Valid N	Sum	Mean	St-dev	Maximum	Minimum
USEMIS	11		3.09	0.30	4.00	3.00
LEARNMIS	11		3.27	0.65	4.00	2.00
USEFACIL	11		3.55	0.52	4.00	3.00
YOUOPER	11		2.36	1.21	4.00	1.00
PERFCHNG	10		3.30	0.48	4.00	3.00
DECQUAL	11	84.55	6.88	90.00	70.00	
INFOASST	11	81.82	9.82	100.00	70.00	
FACLASST	11	82.73	11.04	100.00	60.00	
CEF2	13	594.54	60.73	689.00	488.00	
CEF3	13	591.92	94.36	751.00	469.00	
CEF4	13	640.92	104.61	786.00	509.00	
CEF5	13	679.46	110.62	812.00	504.00	
CEF6	13	710.31	121.55	860.00	568.00	
CEF7	13	731.31	129.16	865.00	548.00	
CEF8	13	764.85	131.19	885.00	575.00	
CEF9	13	745.62	173.71	906.00	513.00	
CEF10	13	768.92	163.26	917.00	554.00	
CEF11	13	781.46	151.08	924.00	575.00	
CEF12	13	780.00	160.21	912.00	559.00	
CEF13	13	791.69	152.68	922.00	579.00	
CEF14	13	803.85	145.97	926.00	596.00	
CEF15	13	793.15	154.69	926.00	571.00	
CEF16	13	796.38	143.68	921.00	593.00	
CEF17	13	809.31	141.55	927.00	608.00	
CEF18	13	808.15	156.93	930.00	586.00	
CEF19	13	818.15	152.63	943.00	599.00	
CEF20	13	827.69	151.66	944.00	610.00	
CEF21	13	830.31	158.41	958.00	599.00	

AGGREGATION BY EXPERIMENTAL GROUP VARIABLES
File EXPDAT (Creation date = 21-Feb-78) FROM PROSIM ON MIS LEARNING

- A G G R E G A T E - -

Group Variables:

FACLTATR	FACILITATOR ORIENTATION
TERMOPER	USE OF A TERMINAL OPERATOR

- -

Group-ID 2 Total N 14 Group-values 1. 2.

Variable	Valid N	Sum	Mean	St-dev	Maximum	Minimum
USEMIS	14		3.57	0.51	4.00	3.00
LEARNMIS	14		3.36	0.84	4.00	1.00
USEFACIL	14		3.50	0.65	4.00	2.00
YOUOPER	14		2.50	1.22	4.00	1.00
PERFCHNG	14		3.21	0.43	4.00	3.00
DECQUAL	14		82.86	11.39	90.00	50.00
INFOASST	14		86.43	8.42	100.00	70.00
FACLASST	14		82.14	13.69	100.00	50.00
CEF2	14		605.00	113.62	721.00	383.00
CEF3	14		603.14	129.59	733.00	387.00
CEF4	14		674.29	126.19	803.00	454.00
CEF5	14		736.00	104.55	844.00	561.00
CEF6	14		765.57	110.52	889.00	604.00
CEF7	14		797.71	89.86	910.00	668.00
CEF8	14		822.00	85.26	931.00	702.00
CEF9	14		839.43	115.06	969.00	649.00
CEF10	14		849.86	103.89	976.00	679.00
CEF11	14		864.00	95.92	969.00	687.00
CEF12	14		873.43	85.36	962.00	700.00
CEF13	14		866.86	87.93	970.00	719.00
CEF14	14		873.71	75.03	958.00	740.00
CEF15	14		875.43	66.95	955.00	760.00
CEF16	14		885.14	61.47	960.00	773.00
CEF17	14		896.29	58.81	974.00	794.00
CEF18	14		913.00	59.15	996.00	811.00
CEF19	14		914.57	56.01	989.00	824.00
CEF20	14		923.43	54.62	998.00	836.00
CEF21	14		929.71	59.68	1011.00	833.00

- -

AGGREGATION BY EXPERIMENTAL GROUP VARIABLES
File EXPDAT (Creation date = 21-Feb-78) FROM PROSIM ON MIS LEARNING

- A G G R E G A T E - -

Group Variables:

FACLTATR	FACILITATOR ORIENTATION
TERMOPER	USE OF A TERMINAL OPERATOR

- -

Group-ID 3 Total N 13 Group-values 2. 1.

Variable	Valid N	Sum	Mean	St-dev	Maximum	Minimum
USEMIS	13		3.00	0.41	4.00	2.00
LEARNMIS	13		3.31	0.48	4.00	3.00
USEFACIL	13		3.31	0.85	4.00	1.00
YOUOPER	13		3.08	0.76	4.00	2.00
PERFCHNG	13		3.00	0.91	4.00	1.00
DECQUAL	13		82.69	9.27	90.00	60.00
INFOASST	13		83.08	7.51	90.00	70.00
FACLASST	13		83.08	16.01	100.00	50.00
CEF2	13		626.15	73.92	720.00	534.00
CEF3	13		614.77	119.13	759.00	418.00
CEF4	13		661.31	80.13	787.00	573.00
CEF5	13		715.38	61.71	815.00	659.00
CEF6	13		735.85	74.95	882.00	676.00
CEF7	13		763.62	50.61	855.00	719.00
CEF8	13		787.77	52.67	878.00	738.00
CEF9	13		789.77	76.65	921.00	709.00
CEF10	13		813.08	74.27	930.00	737.00
CEF11	13		827.38	65.33	930.00	754.00
CEF12	13		839.00	59.84	937.00	783.00
CEF13	13		848.31	57.37	945.00	794.00
CEF14	13		853.15	60.68	949.00	783.00
CEF15	13		860.15	60.35	945.00	798.00
CEF16	13		875.77	57.75	958.00	813.00
CEF17	13		885.54	56.65	963.00	819.00
CEF18	13		896.85	56.48	981.00	831.00
CEF19	13		905.69	54.20	982.00	844.00
CEF20	13		910.38	51.12	985.00	845.00
CEF21	13		920.85	58.20	1012.00	856.00

AGGREGATION BY EXPERIMENTAL GROUP VARIABLES
File EXPDAT (Creation date = 21-Feb-78) FROM PROSIM ON MIS LEARNING

- A G G R E G A T E - -

Group Variables:

FACLTATR	FACILITATOR ORIENTATION
TERMOPER	USE OF A TERMINAL OPERATOR

- -

Group-ID 4 Total N 14 Group-values 2. 2.

Variable	Valid N	Sum	Mean	St-dev	Maximum	Minimum
USEMIS	13		3.31	0.63	4.00	2.00
LEARNMIS	13		3.38	0.65	4.00	2.00
USEFACIL	13		3.46	0.66	4.00	2.00
YOUOPER	13		2.85	0.69	4.00	2.00
PERFCHNG	13		3.38	0.51	4.00	3.00
DECQUAL	13		75.38	11.98	90.00	50.00
INFOASST	13		77.69	15.22	100.00	50.00
FACLASST	13		75.77	12.56	100.00	50.00
CEF2	14		637.71	59.29	774.00	600.00
CEF3	14		644.86	81.91	735.00	493.00
CEF4	14		693.29	79.92	806.00	529.00
CEF5	14		736.14	55.84	773.00	606.00
CEF6	14		783.71	59.88	818.00	644.00
CEF7	14		819.14	56.74	859.00	688.00
CEF8	14		847.14	52.56	878.00	725.00
CEF9	14		872.00	70.18	922.00	710.00
CEF10	14		883.86	70.90	943.00	724.00
CEF11	14		892.57	65.21	956.00	749.00
CEF12	14		888.43	60.73	940.00	754.00
CEF13	14		896.71	57.67	951.00	777.00
CEF14	14		894.14	59.74	954.00	774.00
CEF15	14		894.57	61.45	959.00	775.00
CEF16	14		900.14	60.53	963.00	783.00
CEF17	14		911.57	52.70	958.00	802.00
CEF18	14		916.86	44.12	960.00	834.00
CEF19	14		929.57	40.74	971.00	854.00
CEF20	14		937.86	35.10	977.00	875.00
CEF21	14		936.43	39.19	988.00	871.00

AGGREGATION BY EXPERIMENTAL GROUP VARIABLES
File EXPDAT (Creation date = 21-Feb-78) FROM PROSIM ON MIS LEARNING

- A G G R E G A T E - -

Group Variables:

FACLTATR	FACILITATOR ORIENTATION
TERMOPER	USE OF A TERMINAL OPERATOR

- -

Group-ID 5 Total N 12 Group-values 3. 1.

Variable	Valid N	Sum	Mean	St-dev	Maximum	Minimum
USEMIS	12		3.58	0.51	4.00	3.00
LEARNMIS	12		3.58	0.67	4.00	2.00
USEFACIL	12		3.17	1.11	4.00	0.00
YOUOPER	12		2.67	1.07	4.00	1.00
PERFCHNG	12		3.33	0.49	4.00	3.00
DECQUAL	12		81.67	9.13	90.00	65.00
INFOASST	12		84.17	12.58	100.00	50.00
FACLASST	12		74.58	26.58	90.00	0.00
CEF2	12		604.25	43.90	645.00	523.00
CEF3	12		669.92	76.75	778.00	552.00
CEF4	12		708.92	72.14	809.00	607.00
CEF5	12		746.92	64.52	834.00	664.00
CEF6	12		786.83	68.15	874.00	676.00
CEF7	12		829.00	62.57	915.00	721.00
CEF8	12		859.83	52.26	940.00	761.00
CEF9	12		877.67	54.90	951.00	743.00
CEF10	12		888.67	55.89	965.00	754.00
CEF11	12		901.25	58.11	969.00	760.00
CEF12	12		898.08	46.76	966.00	783.00
CEF13	12		908.83	45.23	978.00	806.00
CEF14	12		911.42	45.60	981.00	809.00
CEF15	12		904.75	43.17	973.00	812.00
CEF16	12		920.17	36.71	974.00	827.00
CEF17	12		935.08	41.14	1000.00	836.00
CEF18	12		946.25	42.61	1013.00	857.00
CEF19	12		945.17	43.83	1022.00	860.00
CEF20	12		953.58	43.19	1018.00	871.00
CEF21	12		967.58	33.45	1002.00	881.00

AGGREGATION BY EXPERIMENTAL GROUP VARIABLES
File EXPDAT (Creation date = 21-Feb-78) FROM PROSIM ON MIS LEARNING

- A G G R E G A T E - -

Group Variables:

FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR

- -

Group-ID 6 Total N 12 Group-values 3. 2.

Variable	Valid N	Sum	Mean	St-dev	Maximum	Minimum
USEMIS	12		3.67	0.49	4.00	3.00
LEARNMIS	12		3.67	0.49	4.00	3.00
USEFACIL	12		3.58	0.51	4.00	3.00
YOUOPER	12		2.92	1.00	4.00	1.00
PERFCHNG	12		3.50	0.52	4.00	3.00
DECQUAL	12		82.50	9.65	90.00	70.00
INFOASST	12		81.67	13.37	100.00	60.00
FACLASST	12		84.17	13.11	100.00	60.00
CEF2	12		614.67	97.66	725.00	453.00
CEF3	12		614.67	42.48	687.00	584.00
CEF4	12		686.83	27.31	717.00	649.00
CEF5	12		747.67	26.97	779.00	706.00
CEF6	12		770.83	39.77	830.00	709.00
CEF7	12		804.00	32.50	836.00	751.00
CEF8	12		838.17	36.37	878.00	789.00
CEF9	12		857.17	68.83	938.00	765.00
CEF10	12		861.50	56.31	932.00	782.00
CEF11	12		865.83	57.08	934.00	776.00
CEF12	12		873.33	61.34	938.00	767.00
CEF13	12		883.17	50.91	943.00	800.00
CEF14	12		885.67	49.55	940.00	806.00
CEF15	12		889.83	44.30	940.00	818.00
CEF16	12		901.00	47.14	942.00	826.00
CEF17	12		913.67	47.97	958.00	834.00
CEF18	12		932.00	47.78	979.00	851.00
CEF19	12		938.50	40.28	978.00	875.00
CEF20	12		947.17	40.16	990.00	878.00
CEF21	12		957.83	43.02	1002.00	884.00

ANOVA OF EXPERIMENTAL GROUPS
ONEWAY ANOVA OF COST EFFICIENCY BY FACILITATOR GROUP
File EXPDAT.W (Creation date = 29-Apr-78) EXPERIMENTAL DATA WITH COVARIATES ADDED

**********O N E W A Y **********

Variable: CEF21 CUM.COST EFFICIENCY:ACT<STD EFF>1000

Multiple range test

Scheffe procedure
Ranges for the .100 Level -

3.08 3.08

The ranges above are table ranges. The value actually compared with Mean(J)-Mean(I) is:
58.2819 * Range * Sqrt(1/N(I) + 1/N(J))

Homogeneous subsets (Subsets of groups, whose highest and lowest means do not differ by more than the shortest significant range for a subset of that size)

Subset 1

Group	GRP001	GRP002
Mean	881.8519	928.9259

Subset 2

Group	GRP002	GRP003
Mean	928.9259	962.7083

ANOVA OF EXPERIMENTAL GROUPS
CONFIDENCE, WITH COVARIATES
File EXPDAT.W (Creation date = 29-Apr-78) EXPERIMENTAL DATA WITH COVARIATES ADDED

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

CEF21 CUM.COST EFFICIENCY:ACT<STD EFF>1000
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR
with GRADE
GPA

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Covariates	51082.154	2	25541.077	4.589	0.013
GRADE	12160.576	1	12160.576	2.185	0.144
GPA	10067.124	1	10067.124	1.809	0.183
Main effects	64300.083	3	21433.361	3.851	0.013
FACLTATR	59830.465	2	29915.232	5.375	0.007
TERMOPER	7183.339	1	7183.339	1.291	0.260
2-way interactions	33201.426	2	16600.713	2.983	0.057
FACLTATR TERMOPER	33201.426	2	16600.713	2.983	0.057
Explained	204404.770	7	29200.681	5.246	0.000
Residual	389617.191	70	5565.960		
Total	594021.961	77	7714.571		

78 cases were processed.
0 cases (0.0 %) were missing.

ANOVA OF EXPERIMENTAL GROUPS
CONFIDENCE, WITH COVARIATES
File EXPDAT.W (Creation date = 29-Apr-78) EXPERIMENTAL DATA WITH COVARIATES ADDED

* * * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

ATTITUDE
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR
with GRADE
GPA

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Covariates	0.523	2	0.261	2.039	0.138
GRADE	0.294	1	0.294	2.294	0.134
GPA	0.008	1	0.008	0.060	0.807
Main effects	0.423	3	0.141	1.101	0.355
FACLTATR	0.291	2	0.145	1.134	0.328
TERMOPER	0.160	1	0.160	1.251	0.267
2-way interactions	0.089	2	0.044	0.346	0.709
FACLTATR TERMOPER	0.089	2	0.044	0.346	0.709
Explained	1.438	7	0.205	1.603	0.149
Residual	8.970	70	0.128		
Total	10.408	77	0.135		

78 cases were processed.
0 cases (0.0 %) were missing.

ANOVA OF EXPERIMENTAL GROUPS
CONFIDENCE, WITH COVARIATES
File EXPDAT.W (Creation date = 29-Apr-78) EXPERIMENTAL DATA WITH COVARIATES ADDED

* * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * * *

CONFID
by FACLTATR FACILITATOR ORIENTATION
TERMOPER USE OF A TERMINAL OPERATOR
with GRADE
GPA

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Covariates	514.491	2	257.245	3.516	0.035
GRADE	164.731	1	164.731	2.251	0.138
GPA	514.491	1	514.491	7.031	0.010
Main effects	114.340	3	38.113	0.521	0.669
FACLTATR	111.793	2	55.897	0.764	0.470
TERMOPER	4.220	1	4.220	0.058	0.811
2-way interactions	328.320	2	164.160	2.243	0.114
FACLTATR TERMOPER	328.320	2	164.160	2.243	0.114
Explained	1008.781	7	144.112	1.969	0.072
Residual	5122.182	70	73.174		
Total	6130.963	77	79.623		

78 cases were processed.
0 cases (0.0 %) were missing.

APPENDIX D

WITHIN CELLS CORRELATIONS OF CRITERIA WITH STANDARD DEVIATIONS ON DIAGONAL

VARIABLE	ATTITUDE	CONFID	CEF21
ATTITUDE	0.358		
CONFID	0.377	8.554	
CEF21	0.164	-0.020	74.605

ESTIMATES ADJUSTED FOR 2 COVARIATES

CONTRAST		CRITERIA ATTITUDE	CONFID	CEF21
F				
	1	-0.048	1.597	-36.868
	2	-0.043	-1.264	3.958
T				
	1	-0.047	0.243	-10.035
FT				
	1	0.042	-0.223	-29.695
	2	0.003	2.650	9.720

TEST OF WITHIN CELLS REGRESSION

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	3.210	6.000	136.000	0.006	0.426
2 THROUGH 2	2.294	2.000	68.500	0.109	0.251

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(2, 70)	MEAN SQ	P LESS THAN	COEFFICIENTS
ATTITUDE	2.039	0.261	0.138	0.556 0.191
CONFID	3.516	257.246	0.035	-0.668 0.813
CEF21	4.589	25541.082	0.013	0.627 0.416

RAW REGRESSION COEFFICIENTS

	VARIATES		
COVARIATES	ATTITUDE	CONFID	CEF21
GRADE	0.007	0.176	1.513
GPA	0.000	-0.066	0.290

TEST OF F

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	2.107	6.000	136.000	0.056	0.387
2 THROUGH 2	0.542	2.000	68.500	0.584	0.125

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(2, 70)	MEAN SQ	P LESS THAN	COEFFICIENTS
ATTITUDE	1.123	0.144	0.331	0.353
CONFID	0.816	59.711	0.446	-0.379
CEF21	5.157	28701.611	0.008	0.849

DISCRIMINANT SCORES

CONTRAST	1
1	-0.537
2	0.059

TEST OF T

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 1	0.900	3.000	68.000	0.446	0.195

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(1, 70)	MEAN SQ	P LESS THAN	COEFFICIENTS
ATTITUDE	1.162	0.149	0.285	0.720
CONFID	0.110	8.023	0.742	-0.458
CEF21	1.492	8305.625	0.226	0.605

TEST OF FT

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	1.985	6.000	136.000	0.072	0.313
2 THROUGH 2	2.283	2.000	68.500	0.110	0.250

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(2, 70)	MEAN SQ	P LESS THAN	COEFFICIENTS
ATTITUDE	0.346	0.044	0.709	-0.527 0.155
CONFID	2.243	164.159	0.114	0.305 -1.030
CEF21	2.983	16600.711	0.057	0.964 0.149

DISCRIMINANT SCORES

CONTRAST	1	2
1	-0.454	-0.014
2	0.216	-0.299

APPENDIX D - CONTINUED

WITHIN CELLS CORRELATIONS OF CRITERIA WITH STANDARD DEVIATIONS ON DIAGONAL ADJUSTED FOR 2 COVARIATES

VARIABLE	USEMIS	LEARNMIS	USEFACIL	YOUOPER	PERFCHNG	DECQUAL	INFOASST	FACLASST	CEF21
USEMIS	0.490								
LEARNMIS	0.418	0.603							
USEFACIL	-0.016	0.244	0.730						
YOUOPER	0.066	0.150	-0.073	0.981					
PERFCHNG	0.105	0.121	0.138	-0.063	0.576				
DECQUAL	0.295	0.176	0.132	0.132	0.366	9.635			
INFOASST	0.344	0.029	-0.118	-0.064	0.108	0.412	11.165		
FACLASST	0.049	0.149	0.459	-0.024	0.321	0.344	0.004	15.716	
CEF21	0.072	0.243	-0.119	0.142	0.104	0.048	-0.049	-0.027	74.605

ESTIMATES ADJUSTED FOR 2 COVARIATES

	CRITERIA						
CONTRAST	USEMIS	LEARNMIS	USEFACIL	YOUOPER	PERFCHNG	DECQUAL	INFOASST
F							
1	-0.019	-0.049	0.089	-0.230	-0.030	1.714	1.727
2	-0.220	-0.086	-0.015	0.201	-0.095	-1.939	-1.611
T							
1	-0.132	0.025	-0.090	0.035	-0.075	1.047	0.618
FT							
1	-0.073	0.041	0.151	-0.033	0.125	0.057	-1.996
2	-0.018	-0.004	0.011	0.136	-0.112	2.173	1.959

	CRITERIA	
CONTRAST	FACLASST	CEF21
F		
1	1.350	-36.868
2	-0.242	3.958
T		
1	-0.936	-10.035
FT		
1	1.269	-29.695
2	3.819	9.720

TEST OF WITHIN CELLS REGRESSION

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	1.438	18.000	124.000	0.125	0.483
2 THROUGH 2	0.936	8.000	62.500	0.493	0.327

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS
VARIABLE	F(2, 70)	MEAN SQ	P LESS THAN	1
USEMIS	0.094	0.023	0.910	-0.200
LEARNMIS	4.682	1.703	0.012	0.644
USEFACIL	1.457	0.776	0.240	-0.031
YOUOPER	1.641	1.579	0.201	0.297
PERFCHNG	0.037	0.012	0.963	0.146
DECQUAL	2.191	203.353	0.119	-0.387
INFOASST	1.395	173.933	0.255	0.159
FACLASST	2.081	513.857	0.133	-0.314
CEF21	4.589	25541.082	0.013	0.460

RAW REGRESSION COEFFICIENTS

	VARIATES						
COVARIATES	USEMIS	LEARNMIS	USEFACIL	YOUOPER	PERFCHNG	DECQUAL	INFOASST
GRADE	0.003	0.016	0.013	0.003	0.002	0.161	0.220
GPA	-0.000	0.001	-0.003	0.004	-0.000	-0.058	-0.049

RAW REGRESSION COEFFICIENTS

	VARIATES	
COVARIATES	FACLASST	CEF21
GRADE	0.147	1.513
GPA	-0.090	0.290

TEST OF F

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	1.309	18.000	124.000	0.193	0.440
2 THROUGH 2	1.105	8.000	62.500	0.372	0.352

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(2, 70)	MEAN SQ	P LESS THAN	COEFFICIENTS
USEMIS	5.270	1.264	0.007	0.760
LEARNMIS	0.924	0.336	0.402	-0.120
USEFACIL	0.304	0.162	0.739	-0.033
YOUOPER	1.256	1.208	0.291	0.003
PERFCHNG	0.884	0.293	0.418	0.313
DECQUAL	1.011	93.825	0.369	-0.210
INFOASST	0.646	80.546	0.527	-0.227
FACLASST	0.157	38.780	0.855	-0.125
CEF21	5.157	28701.611	0.008	0.620

TEST OF T

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 1	1.878	9.000	62.000	0.072	0.463

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(1, 70)	MEAN SQ	P LESS THAN	COEFFICIENTS
USEMIS	5.478	1.314	0.022	0.956
LEARNMIS	0.139	0.051	0.711	-0.635
USEFACIL	0.952	0.507	0.333	0.434
YOUOPER	0.115	0.110	0.736	0.012
PERFCHNG	1.190	0.394	0.279	0.330
DECQUAL	0.984	91.352	0.325	-0.543
INFOASST	0.217	27.093	0.643	-0.158
FACLASST	0.159	39.250	0.691	0.032
CEF21	1.492	8305.625	0.226	0.400

DISCRIMINANT SCORES

CONTRAST	1
1	-0.505

TEST OF FT

MULTIVARIATE TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION

TEST OF ROOTS	F	DFHYP	DFERR	P LESS THAN	R
1 THROUGH 2	1.110	18.000	124.000	0.350	0.387
2 THROUGH 2	1.143	8.000	62.500	0.348	0.357

	UNIVARIATE F TESTS			STANDARDIZED DISCRIMINANT
VARIABLE	F(2, 70)	MEAN SQ	P LESS THAN	COEFFICIENTS
USEMIS	0.668	0.160	0.516	0.219
LEARNMIS	0.100	0.036	0.905	-0.344
USEFACIL	1.076	0.573	0.346	-0.134
YOUOPER	0.406	0.390	0.668	0.006
PERFCHNG	1.113	0.369	0.334	-0.584
DECQUAL	1.306	121.231	0.277	0.028
INFOASST	0.824	102.669	0.443	0.349
FACLASST	2.069	510.902	0.134	0.267
CEF21	2.983	16600.711	0.057	0.795

APPENDIX E

PROSIM: Production Simulation Game - Initial Handout

Products

	raw material required	std.pdctn. rate	setup hours required
X	1 unit	50/hour	1 hour
Y	2 units	40/hour	2 hours
Z	3 units	30/hour	3 hours

Production Lines

Line 1: Input is raw material; output is intermediate goods (X^1, Y^1, Z^1): 4 machines available; $10 per machine hour equipment usage cost; line 1 output not available to line 2 on same day.

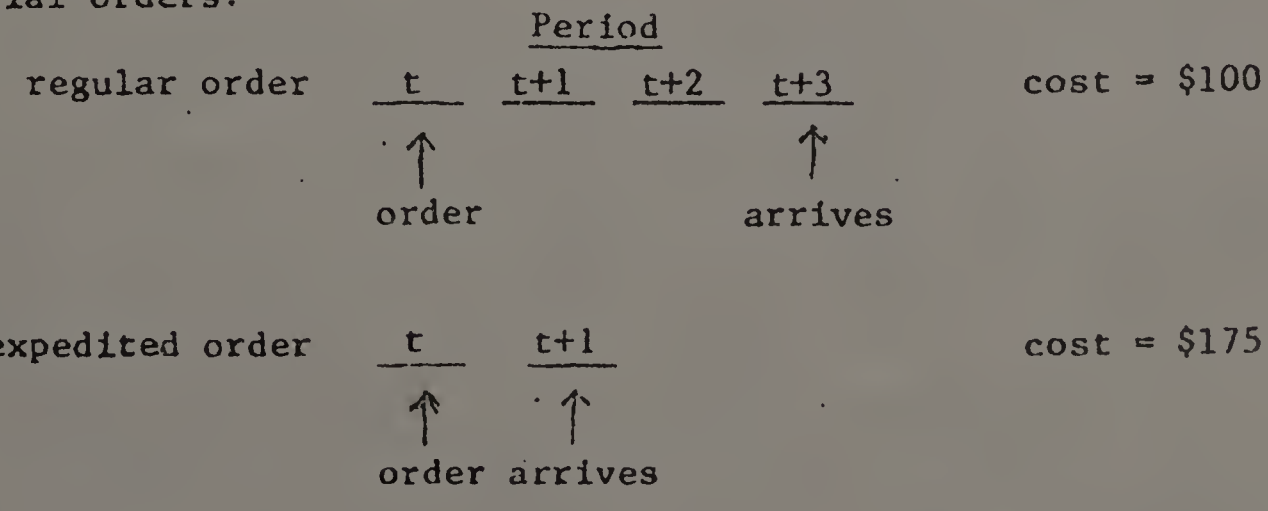
Line 2: Input is intermediate goods (X^1, Y^1, Z^1); output is finished goods (X, Y, Z); 4 machines available; $10/hour/machine equipment wage cost; line 2 output immediately available for shipment.

Raw Material

Required for input to line 1; see unit requirement by product above.

Raw material carrying cost = $.015/unit per period.

Raw material orders:



Raw material quantity discount structure:

units	cost per unit
0 - 4999	$1.00
5000 - 14999	.90
15000 - 24999	.85
25000 or more	.80

Quality Control

Tests on line 2 only.

Reject rate is a function of quality control expenditures.

Maintenance

Maintenance expenditures (past and present) determine machine breakdown levels.

Machine breakdown costs: $100/machine repair cost plus 2 hours downtime for repair.

Labor

See Exhibit 1 for list of available workers and estimates of potential.

Can use up to 12 hours per worker per period:

8 hours regular time at $3/hour

4 hours overtime at $4.50/hour

Union requires minimum 4 hours pay for any assigned worker.

Hiring cost: $50/worker

Layoff cost: $8/day per worker

Firing cost: $25/worker (automatically incurred when worker is not used for 3 consecutive days; layoff costs incurred on days 1 and 2, firing cost incurred on day 3.)

Training cost: $20/day/worker; during training worker performs at previous rate.

Inventory carrying costs per period:

Raw material:		$.015/unit
Intermediate goods:	X^1	.02/unit
	Y^1	.03/unit
	Z^1	.04/unit
Finished goods:	X	$.03/unit
	Y	.05/unit
	Z	.07/unit

Demand

See Exhibit 2 for demand forecasts.

Shipments occur every third period only; shipment is to a firm demand commitment.

Backorder costs:	X	$3/unit
	Y	4/unit
	Z	5/unit

PROSIM administrative details:

NO RE-RUNS: errors due to illegibility can seriously affect your company's performance; check your input forms carefully.

Game evaluation: you are required to maintain and post (every third period) your company's efficiency rating; Exhibit 4 is an efficiency rating form.

Exhibit 5 is the output from period 1 for all companies.

Exhibit 6 is a set of input forms.

PROSIM USER'S INSTRUCTIONS

General Procedures

A program is stored in the University's DEC-10 computer which calculates and prints the results of each period's operation. The team members are responsible for executing the program for each assigned PROSIM period. To do so, the following tasks must be accomplished.

(1) Determine the decisions for the period to be run. (The first period to be run is period Ø2. The results of period Ø1 operations are included in this handout. Enter the decisions on a decision form.

(2) Execute the PROSIM program from a computer terminal.

Detailed Instructions

Note: If you experience difficulty in any of the following steps, ask the consultant on duty in the terminal area for instruction.

Computer Terminals: There are two kinds of terminals available at UNH: The DecWriter and the Video (TV) terminals. The DecWriter prints on paper much like a typewriter, while the Video terminal displays information on a TV screen. Either may be used, and instructions will be given for both types. (The IBM terminal at Kingsbury should not be used).

There are two main locations for terminals on campus: McConnell Hall Room 101, and Kingsbury Hall Room ..... Other areas also have terminals (see attached list).

Terminal Preparation: The computer terminal must be made ready for operations before it can be used. Follow the steps below:

Video Terminals:

1. Depress the Power ON/OFF button.
2. Make sure the three buttons at the top of the keyboard are in the following positions:

DecWriter Terminals:

1. Push all three switches at the left of the keyboard to the up position ("ON", "line", "300").
2. The "lock" key should be up.

LOGIN Procedure: The computer must first be made aware of the identity of the user before it will function. Each user is identified by a "project-programmer" number (called a "PPN") and a password which ensures that only legitimate users are allowed access to the computer, and that each

user's work will be protected and kept confidential. The user identifies himself/herself by the "LOGIN" procedure. To gain access to the PROSIM program, LOGIN by typing.

LOGIN aaaa, bbbbb

Where aaaa, bbbbb is your "project-programmer" number (PPN).

Each line entered by the user must be terminated by depressing the "RETURN" key on the DecWriter on the "NEW LINE" key on the Video terminals. This advances the terminal to the next line and informs the computer that the line just typed in is ready for processing.

The computer will respond with a brief message and will then ask for the user's password by typing:

PASSWORD:

The user must then type his password. The Prosim Password is 122341. These characters will not be printed so as to ensure the security of the password. Follow the password characters with the return (NEW LINE) key. If the password is correct, the computer will begin typing notices of interest to computer users. If incorrect, the computer will ask that the user's project-programmer number and password be retyped. Again, each entry must be followed by the return (NEW LINE) key.

Running the PROSIM Program

When the computer is ready to begin accepting instructions from the user, it will so indicate by typing a period. The first task to be accomplished by the computer is to run the PROSIM program. Hence the next step is to type:

RUN PROSIM [2000,10021]

Note that the brackets must be the square brackets not the curved. Again, a return (NEW LINE) entry must be made. The PROSIM program will now be executed by the computer.

PROSIM Program

The PROSIM program begins by typing some general instructions and information which is discussed below.

The program will next request the team number and team password. These numbers serve to identify the team and protect its' data files. If the team number and password do not agree, the program will request that they be reentered until correct. Team numbers and team passwords will be assigned in class.

Next, the decisions are requested. Only numbers may be entered. The decision form lists all decisions in the order requested by the program.

APPENDIX F - CONTINUED

When all decisions have been entered a summary of the decisions will be typed. Check all numbers carefully, since this will be the last opportunity to correct typing errors. The program will then ask if the decisions are correct. If "yes" is entered, the program will be executed. If no, the program will request that all decisions be reentered.

Printing the Results

When the PROSIM program has finished its calculations the computer will type a period indicating that the computer is ready for further instructions. Type the command:

K/F

The computer will submit the results for printing and release the terminal for other users. Note that the K/F command must be given prior to turning the terminal off.

When the results have been printed they will be made available by the consultant or operator.

Correcting Typing Errors

Several techniques can be used to correct typing errors. The technique used depends on whether the return (new line) key has been depressed.

Correcting errors before the return key is depressed: Incorrect characters may be erased by depressing the rubout key once for each character to be erased. The computer "backs up" one character for each rubout. Thus if 3ØØØ is to be entered, but 3Ø9Ø is entered instead, the rubout key should be depressed twice to erase the last two characters (9Ø). The correct characters (ØØ may then be typed. Note that the last zero must be erased in order to erase the incorrect 9.

Correcting errors after the return key is depressed:
The PROSIM program allows incorrect entries to be changed in two ways:

(1) By entering -1 for a decision variable the previous entry is repeated and may be changed. In the case of production line decisions a -1 entry will cause the entire line to be repeated.

(2) When all decisions have been entered the program asks for confirmation that all decisions have been correctly entered. A yes response executes the calculation portion of the program, a no response repeats the entry of all decision variables.

Problems

There are several potential problems which might be encountered which will cause the program to stop execution. These problems range from an incorrect data entry (a letter is typed instead of a number

for example) to a computer failure ("crash"). In general, if a problem is encountered before the yes/no confirmation question is answered, the program may be restarted by following the procedure below:

(1) Hold down the Control key and depress the C key twice.
(2) When the computer responds with a period type RUN PROSIM [2000,10021]

If the problem is encountered after the yes/no confirmation question is answered, Notify your instructor.